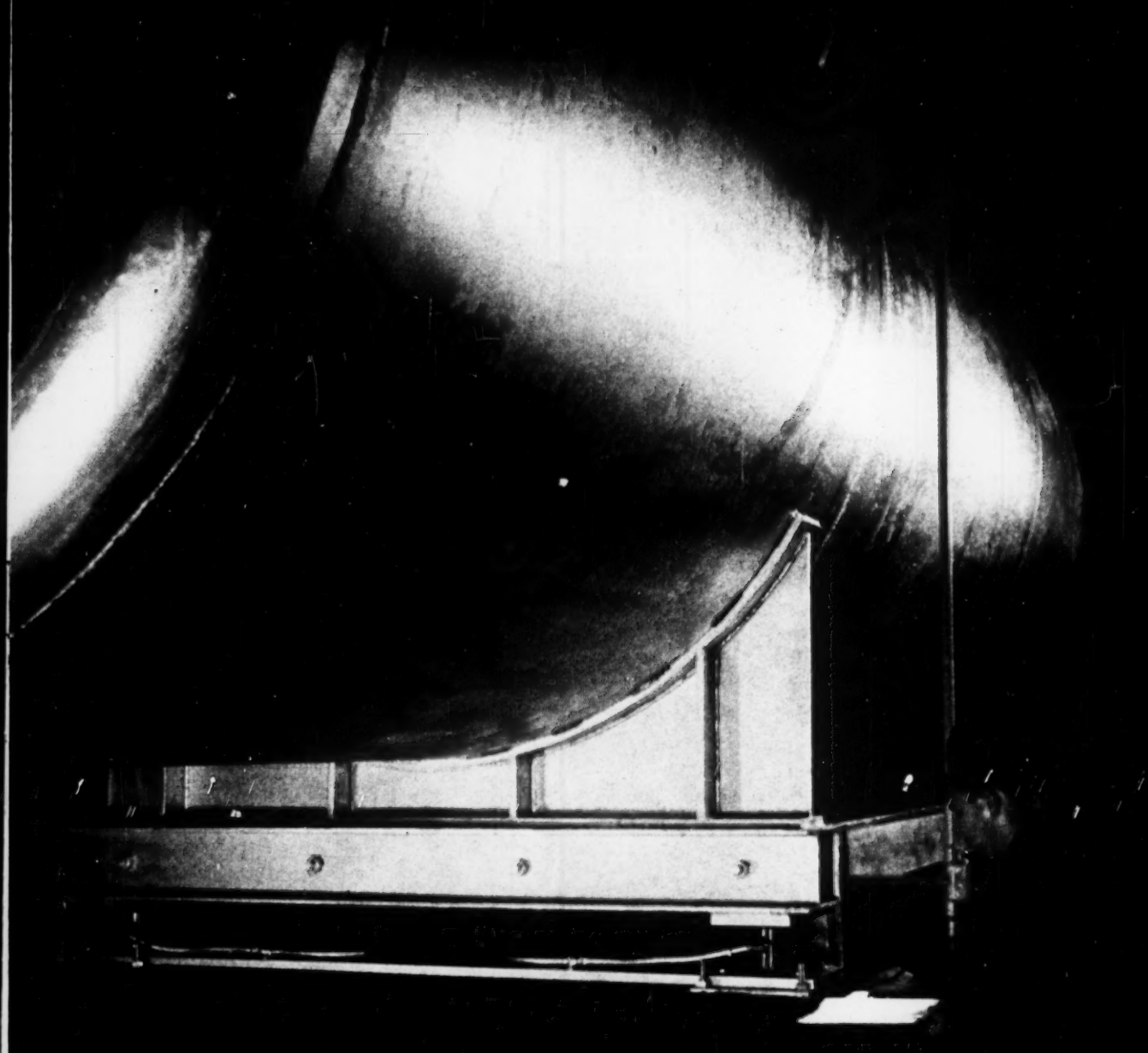
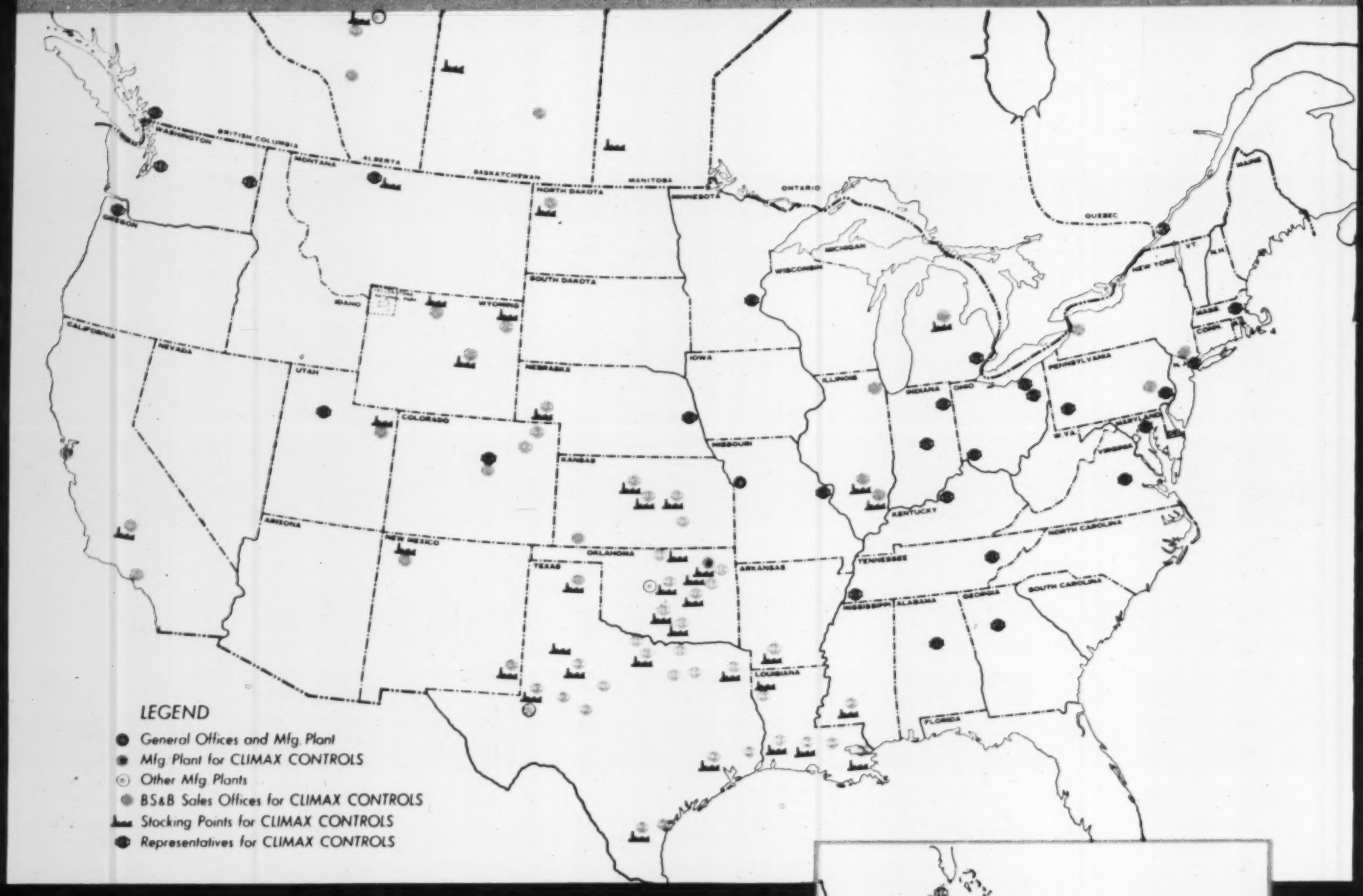
Instruments *and* AUTOMATION



121 BS&B CLIMAX CONTROLS CENTERS...


LEGEND
General Offices and Mfg. Plant
Mfg. Plant for CLIMAX CONTROLS
Other Mfg. Plants
BS&B Sales Offices for CLIMAX CONTROLS
Stocking Points for CLIMAX CONTROLS
Representatives for CLIMAX CONTROLS

...Serving Industry In The Americas!

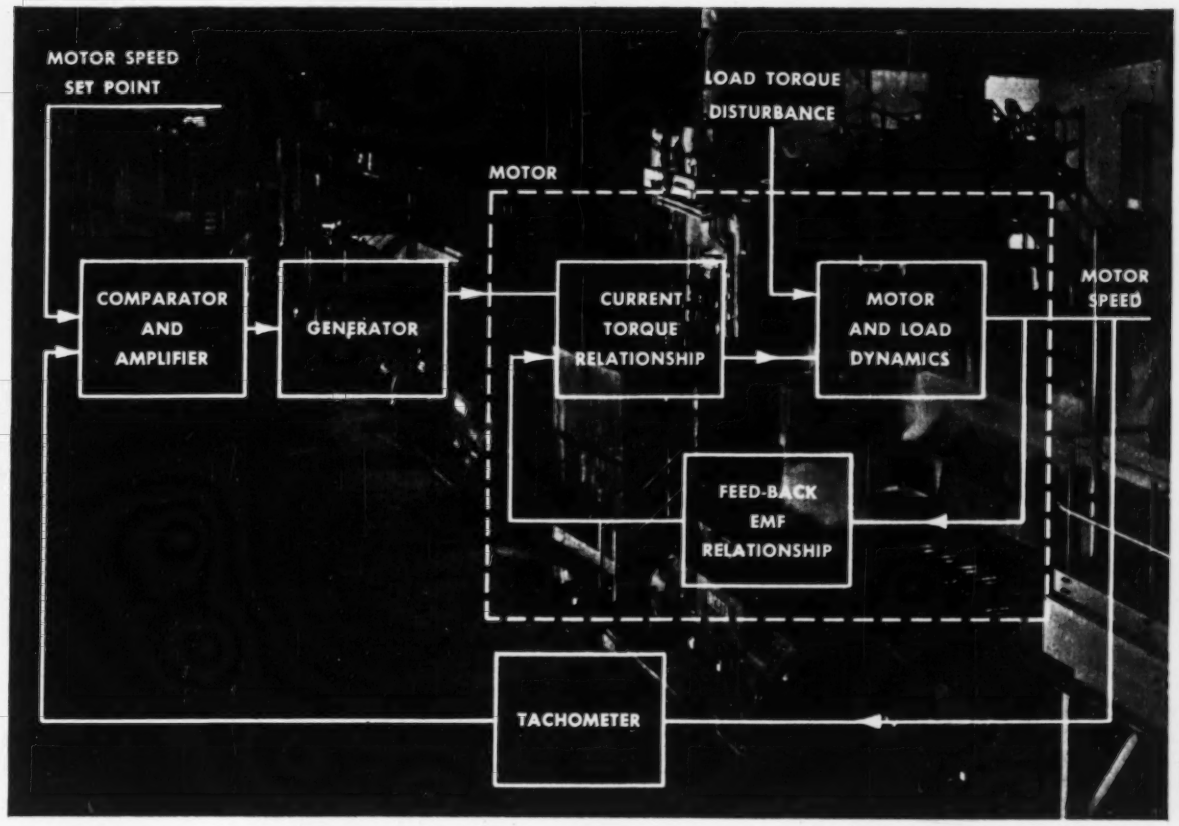
For Your Convenience

No matter where you are located in the United States, Canada or the Latin American countries . . . these BS&B Climax Controls sales and service centers are prepared to give you fast, efficient and convenient service on the finest in automatic controls for the regulation of pressures, temperatures, liquid levels and flow. From these centers, including 40 strategically located warehouse stocks of Climax Controls and parts, Climax sales engineers are quickly available to render service on existing equipment or to help you plan new installations. For additional information or a Climax Controls catalog, contact your nearest Climax Controls Center, or write to . . .

BLACK, SIVALLS & BRYSON, INC.
Climax Controls Division, Dept. 4-V11
7500 East 12th Street
Kansas City 26, Missouri

EFFICIENCY OVER 40 YEARS BS&B RELIABILITY

For more information circle 1 on inquiry card.



GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

GEDA SOLVES CONTROL PROBLEMS

FOR THE STEEL INDUSTRY or ANY INDUSTRY! Set up your own problem—inject your own variables!

GEDA – analog computing equipment of advance design by Goodyear Aircraft—*facilitates the analysis and solution of difficult control problems facing your industrial operations right now.*

ITS ADVANTAGES ARE MANY:

Versatility—For example, the basic unit—the linear L3 GEDA—will accommodate two nonlinear plug-in units, in addition to its 24 stabilized computing amplifiers. The nonlinear GEDA, the N3, will handle 10 plug-in units.

Accuracy—GEDA plug-in units—automatically and continuously stabilized – are noted for their electronic accuracy. The GEDA stabilized electronic multiplier is the acknowledged leader in the field.

Easy To Use—Development engineers do not have to learn specialized mathematics in order to save time with GEDA, for this modern equipment delivers results in wave forms and voltages—forms with which engineers are used to dealing.

GEDA offers a complete line—engineered against obsolescence; particularly suited to meet both your present requirements and possible future expansions. Why not let a GEDA representative show you how well GEDA can serve you?

FREE CATALOG ON REQUEST

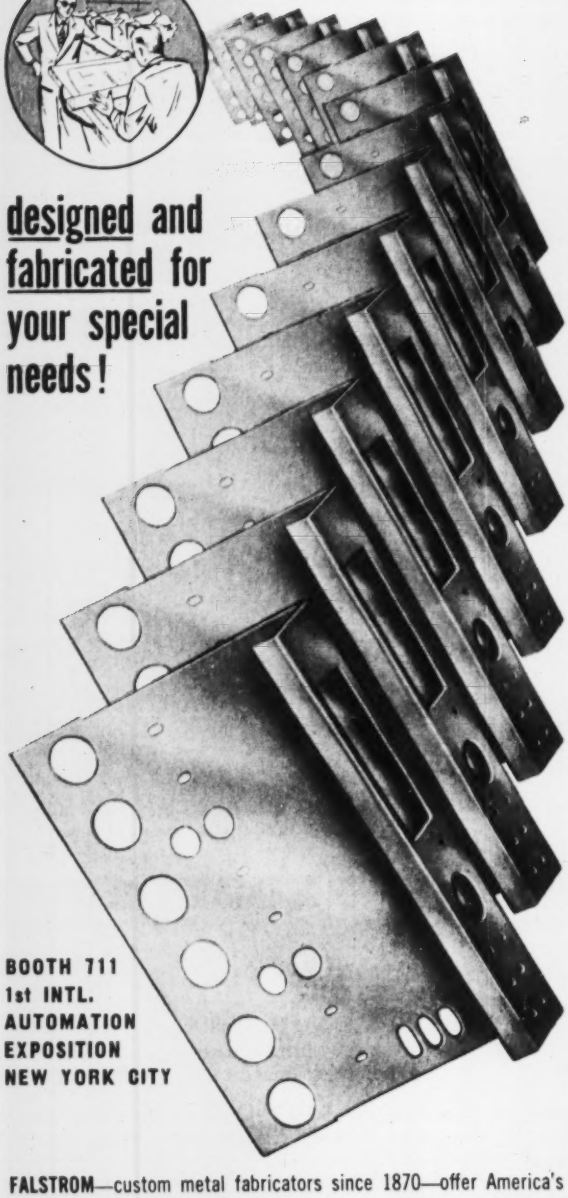
Address: Goodyear Aircraft Corporation, Dept. 931-EW, Akron 15, Ohio.

save time with **GEDA!**

GOODYEAR AIRCRAFT

For more information circle **2** on inquiry card.

designed and fabricated for your special needs!



BOOTH 711
1st INTL. AUTOMATION EXPOSITION
NEW YORK CITY

FALSTROM—custom metal fabricators since 1870—offer America's most up-to-date facilities for the manufacture of large or small parts in sheet steel, aluminum, copper, brass and other alloys to closest tolerances . . . on long or short runs. A to Z fabrication under one roof is another advantage that saves you costs and avoids delays.

FALSTROM makes all kinds of instrument panels, graphic panels, cabinets, chassis, cubicles, consoles and metal fabricated parts for all industrial purposes. Consult Falstrom for custom contract manufacturing at practical unit cost. Send us your blueprints for quotation or ask about our standard designs. **Write for Bulletin 143-A.**

Falstrom means it's that much better!

FALSTROM CO.
82 Falstrom Court • Passaic, New Jersey

For more information circle **3** on inquiry card.

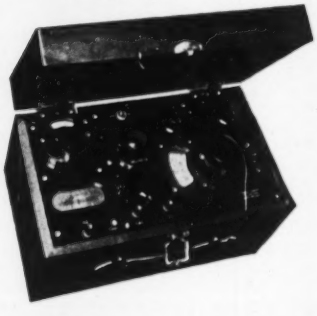
Precise
TEMPERATURE MEASUREMENTS

. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



. . . with the Rubicon
PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY
Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **4** on inquiry card.

Contents...

Vol. 27, No. 11, November 1954

Instruments and AUTOMATION

Richard Rimbach, Publisher
Manoel F. Behar, Editor
Milton H. Aronson, Technical Editor
James Emge, Associate Editor
David S. Aland, Associate Editor
Milo D. Pugh, Western Editor
Armand Gaudreau, Consulting Editor (Automation)

District Offices and Managers

Altadena, Calif., Milo D. Pugh & Associates: M. D. Pugh, 2721 N. Marengo Ave., SYcamore 7-2894; Hunter Vinton, 1050 Lincoln Ave., Palo Alto, Calif., DA 5-4815

Boston 16, Mass. Harold H. Short, Jr., Holt Road, Andover, Mass., Andover 2212

Chicago 1, Ill. Harold W. Haskett, 1205, 228 N. La Salle St., Central 6-8963

Cincinnati 5, Ohio. Harold W. Haskett, 742 Elberon Ave., Grandview 4323

Dallas, Texas. Edward F. Wright (Oklahoma-Texas-Louisiana) 505 N. Ervay, Rm. 310. Prospect 0189

New York 17, N. Y. Richard Rimbach, Jr., 525 Lexington Ave., Rm. 359, Murray Hill 2-0821

Philadelphia, Pa. Robert H. Maxwell, 7 Wilde Ave., Drexel Hill, Pa., Clearbrook 9-4342 (Phila. Suburban)

Pittsburgh 12, Pa. C. Goldcamp, 845 Ridge Ave., Fairfax 1-0161

St. Louis 1, Mo., James R. Wright (Missouri, Southern Illinois, Southern Indiana), Stephen E. Wright (Iowa, Nebraska, Kansas), 706 Chestnut St., Chestnut 1-1965

London. W.1, England. John C. N. Hughes, Crown House, 143-147 Regent St., Regent 3891

MEMBER ABC Audit Bureau of Circulation.

SUBSCRIPTION RATES
For One and Two Years.
United States, U. S. Possessions, and Canada $4.00, $7.00 (2 yrs.).
Latin America and Australia $5.00, $8.00 (2 yrs.).
All other countries except those noted below $6.00, $10.00 (2 yrs.).

For the present, subscriptions not accepted from Austria, Bulgaria, China, Czechoslovakia, Eastern Zone Germany, Hungary, India, Poland, Romania, Russia and Yugoslavia. Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. Bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.

Editorial

First International Automation Exposition 1719
Listing of Automation Show Exhibitors and their Products 1720
Review of the First International Instrument Exposition .. 1723

Feature Articles

Special Instruments for the Steel Industry 1786
by W. A. Black
Measurement Technique for High Vacuum 1792
by Kenneth Roach
The High-Vacuum Standard—The McLeod Gage 1795
by Earl W. Flosdorf
Fundamentals of Analog Computers 1797
by J. A. McDonnell
The Automatic Factory—A Critical Examination 1804
by S. A. June, et al
Watthour-meter Testing 1806
Automatic Tank Weighing 1807
by J. A. Openshaw
A Low-Noise Grid-Controlled Thyratron—The Tacitron 1808
by E. O. Johnson, J. Olmstead and W. M. Webster
Time-Proportional Thermostat 1809
Effect of Edge Thickness on Small Orifice Meters 1810
by L. W. Thrasher and R. C. Binder
Scale and Reading Errors of Electrical Indicators 1812
by Frank D. Weaver
Instrumentation of Modern By-Product Coke Ovens 1815
by E. T. W. Bailey
A Stable Noise-Generator 1818
by J. D. Shaffer

New Feature

Test Your I.Q. (Instrument Quotient) 1824

Journal of the Southern California Meter Association

Instrumentation of Underground Gas Reservoirs 1820
by Raymond W. Todd

Other Regular Features

Trends 1683
On the March 1684
New Instruments 1727
Events Calendar 1829
Briefs 1830
New Literature 1842
Searchlite Section 1862
Advertisers' Index 1864

Cover Story

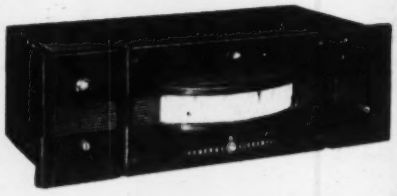
Installation of Baldwin "SR-4" load cells for gaging Freon tanks at Stanley Home Products Inc., Easthampton, Mass. For complete story see page 1807. Photo courtesy Baldwin-Lima-Hamilton Corp.

Copyright 1954, published monthly, by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Entered as second class matter, October 14, 1949, at the post office at Pontiac, Illinois, under the act of March 3, 1879.

LONG TERM ACCURACY and precision of measurement are assured with the new G-E potentiometric recording system. It is designed for continuous control, even at 0 F ambient temperatures. The "floating" pointer gives you increased chart visibility; makes chart changing simple and helps to reduce servicing time to a minimum. Elimination of the frontally-connected pointer and complicated holding devices reduces paper changing to a quick, smooth operation.

USE G-E PYROMETERS FOR ACCURATE CONTROL

General Electric Pyrometers Give Dependable Protection



TYPE HP-3 PYROMETER, a two-position controller, has positive control action, initiated by 0.1 percent in full-scale movement of instrument pointer. This gives accurate readings from easy-to-read 7-inch scale. Units are available for flush or surface mounting. Indicator, controller, and protector units are plug-in type, permitting easy servicing

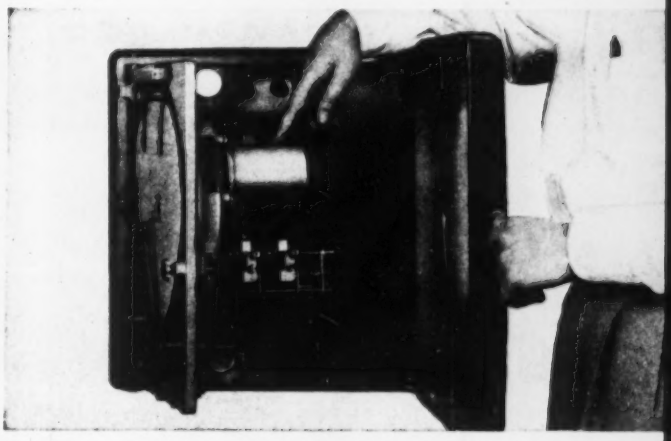
Newly Designed G-E Recording Controller Eliminates Many Troublesome Components

Provides Truly Continuous Standardization

General Electric's new d-c recording controller assures you of having less maintenance by eliminating conventionally used dry cells, standard cells, slidewire and sliding contacts. Replacement costs for dry cells, or worn, corroded electrical contacts are gone, and servicing time is reduced at no extra cost.

THE MAGNETIC STANDARD provides truly continuous standardization through the revolutionary measurement-circuit design, which incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control during standardization periods can never be experienced with the constantly balancing G-E system.

NEW RECORDING CONTROLLER offers such features as: long term accuracy and precision of measurement continuous, dependable control; increased chart visibility; simplified chart changing; and better protection of processes against damage due to component failure. These features mean more cost and time savings in your process operations.



COMPACT CONSTRUCTION assures servicing ease for minimum of maintenance required. The controller has a maximum number of plug-in-parts to facilitate range changing in the field. No unsoldering is required.

G-E HAND PYROMETER DESIGNED FOR WIDE USE

GENERAL ELECTRIC COMPANY
SECTION C 602-277
SCHENECTADY 5, NEW YORK

Please send me a copy of the bulletins checked below:

- ☐ GEA-6020 Hand Pyrometer
- ☐ GEC-714 Thermocouples and Accessories
- ☐ GED-2100 New Recording Controller

Name .....

Company .....

Street .....

City ..... Zone ..... State .....

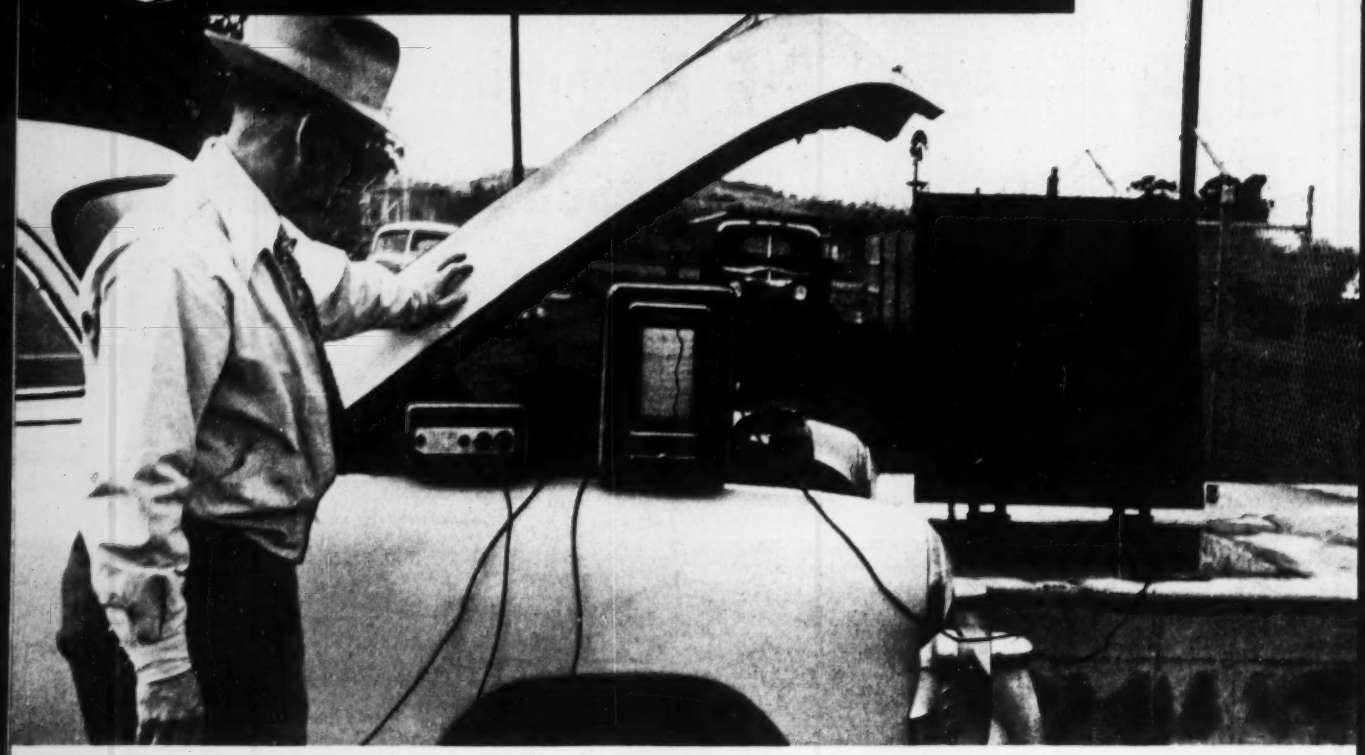
DUAL-RANGE General Electric hand pyrometer is designed for flexible and inexpensive measurement of gas, surface and molten-metal temperatures.

EASY-TO-USE hand pyrometer accurately indicates temperature of precision castings. Instrument is lightweight with non-slip, bayonet-grip handle.

GENERAL ELECTRIC

For more information circle 5 on inquiry card.

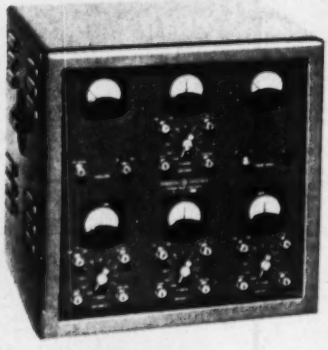
INSTRUMENTS FOR LABORATORY MEASUREMENT



LABORATORY FIELD TESTS are successfully conducted by the East Bay Municipal Utility District, Oakland, California, by using G.E.'s photoelectric recorder to locate pipe-line corrosion. Fred Terry, District Corrosion engineer, found that this recorder provided the most satisfactory method of determining where corrosion danger exists. The recorder was used to make electrolysis surveys of a 94-mile stretch of pipe. A car battery and 60-cycle vibrator furnished the power. The recorder does not need constant balancing.

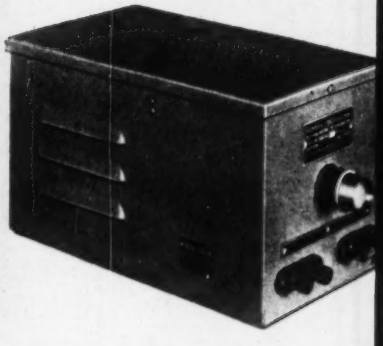
News About Other General Electric Instruments for Precision Measurement in the Laboratory

STRAIN GAGE AMPLIFIER



STABILIZED for line-voltage, or tube-characteristic variations, the strain gage amplifier operates on d.c. or 0 to 1500 cps a.c. Two-channel, $1900.00; four-channel, $3200.00*.

SELF BALANCING POTENTIOMETER



HIGHLY STABLE MEASURABLE CURRENTS are furnished from small d-c voltages. Input: 100 uv to 1 v, d.c. Output: 5 ma d.c. for all output circuits up to 1500 ohm. $258.19*.

*Manufacturer's suggested retail price.

For more information circle 6 on inquiry card

FROM LABORATORY ANALYSIS TO FIELD TESTING . . .

G.E.'s Portable Photoelectric Recorder Assures Precise, Convenient Measurement

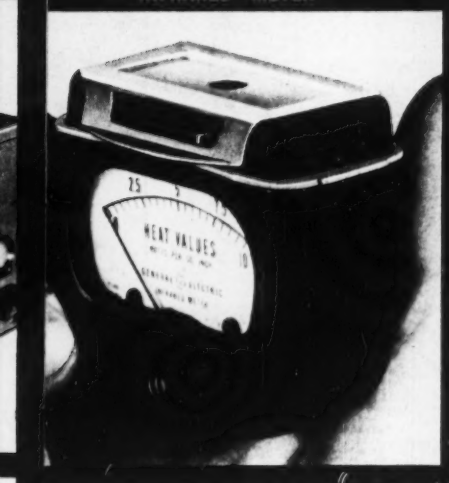
Designed for recording rapidly changing phenomena, General Electric's photoelectric recorder features unlimited versatility combined with the convenience of portability. With sensitivity and response characteristics of the most sensitive indicating instrument, the portable photoelectric recorder can provide direct ink records of the transient phenomena being investigated.

HIGH-SPEED RESPONSE, as high as 1/5 second for full-scale deflection, is another outstanding feature of G.E.'s recorder. Chart speeds range from ½ inch per hour to 72 inches per minute, and sensitivities are as great as 1.0 microamperes full-scale. Single-, double-, and triple-speed chart carriages are available.

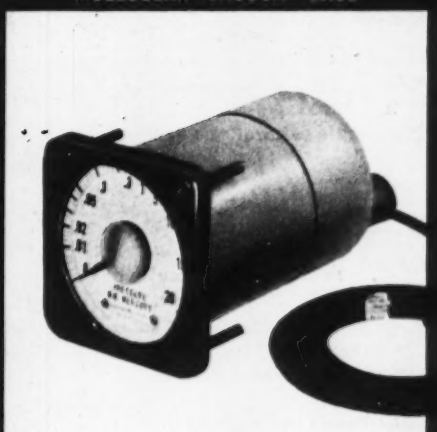
HIGHLY VERSATILE, G.E.'s photoelectric recorder is ideal for any permanent or temporary test where only a small amount of energy is available to deflect the recorder pen. The amount of energy required to operate the portable recorder can be in the order of one millionth of the energy required to operate a direct-acting recorder.

DESIGNED FOR PORTABLE USE, the photoelectric recorder is supplied with a convenient carrying strap and weighs but 35 pounds. The recorder can be used to record electrical quantities, such as volts, amperes, and frequency, and non-electrical quantities, such as speed, sound, pressure, strain, light, and vibration. Price is $698.88*.

INFRARED METER



MOLECULAR VACUUM GAGE



SIMPLE AND CONVENIENT measurement of radiant energy intensity of 0 to 10 watts per sq. in. is provided. Response range is 0.3 to 3.5 microns. Price, $48.75* or $67.47*.

NO PRIMARY ELEMENT TO BURN OUT, this new gage is provided with a dry-air scale of 0 to 20 mm; or for other gases, 0 to 100 uniform scale divisions. Price, $195.00*.

SECTION B605-75
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Strain Gage Amplifier (GEC-1248)
- ☐ Self-Balancing Potentiometer (GEC-367)
- ☐ Radiation Meter (GEC-381)
- ☐ Molecular Vacuum Gage (GEC-986)
- ☐ Photoelectric Recorder (GEC-254)

Name .....

Company .....

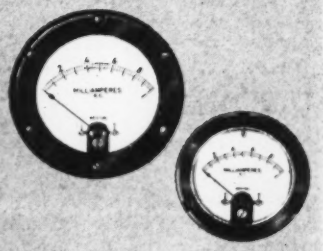
Street .....

City ..... **Zone** ..... **State** .....

GENERAL ELECTRIC

For more information circle 6 on inquiry card

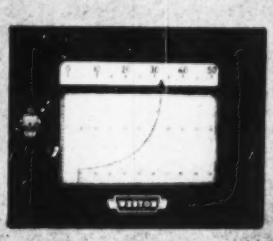
designer's INSTRUMENT guide



RUGGEDIZED INSTRUMENTS —to military specifications, available in 2½", 3½" and 4½" sizes in D-C, movable iron A-C, rectifier type A-C and thermo instruments. All have sealed, externally operated zero correctors—shock-resisting, flat plastic windows—and connection terminals molded into internal rubber.

ULTRA-SENSITIVE RELAYS —extremely compact and rugged relays which operate on values as low as ½ microampere or ¼ millivolt, direct from thermocouples, resistance bulbs or other generators of minute current. Handle substantial wattage at 110 volts on non-chattering magnetic contacts. Available with single or double contacts, fixed or adjustable, manual or solenoid reset.

"MOTOR LOAD %" METERS —WESTON "per-cent load" ammeters and wattmeters make it easy for operators to secure optimum production from lathes, milling machines, automatics, grinders, etc. Prevent overloading—reduce tool breakage—assure uniform quality with fewer objects. Other scale calibrations available.



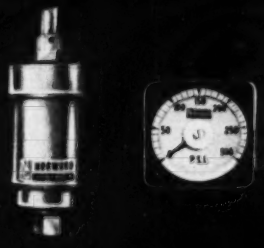
RECORDING POTENTIOMETER —ideal for built-in needs because of its extreme compactness plus ruggedness and simplicity. Ranges changed simply by inserting required range standards. Chart speeds changed by simple screwdriver adjustment. Plug-in amplifier removed in a jiffy since no soldered connections are used.

Literature on any of the above instruments sent on request.
WESTON Electrical Instrument Corporation,
614 Frelinghuysen Avenue, Newark 5, New Jersey.

8106

WESTON *Instruments*

For more information circle **7** on inquiry card.



new word

for reliability
and ruggedness
in pressure and temperature measurement

ELECTROSYN stands for simplicity in design . . . ruggedness in construction . . . reliability in performance. Offering revolutionary advancements in remote indication and control of pressure and temperature, ELECTROSYN is available in an explosion-proof construction which permits location in hazardous areas.

NORWOOD CONTROLS ELECTROSYN Detectors are based on a unique signal generator. This generator is a high resolution, electromagnetic rotary transducer producing full scale linear output. Fluid pressure in a twisted Bourdon tube, or a temperature sensitive bi-metallic ribbon helix, rotates the signal generator a minute amount, producing a proportional electrical signal.

ELECTROSYN's exceptionally high output signal, electrically transmitted, makes possible accurate remote readings of temperature and pressure without complex electronic circuits.

NC CONTROLS

Controls Division

CONTROL ENGINEERING CORPORATION

932 Washington Street • Norwood, Mass.

Complete technical information will be supplied upon request

For more information circle ■ on inquiry card.

LEWIS

RESISTANCE THERMOMETER AND ACCESSORIES

The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

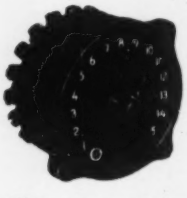
ACCESSORIES — RESISTANCE BULBS AND SWITCHES

Lewis Selector Switches have been used for years in automotive test work as well as in permanent installations. Simple, sturdy construction plus finest materials combine to give long service.

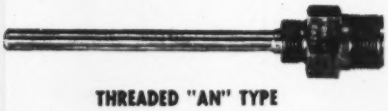
FREE AIR

2" SIZE TO 4 POINTS

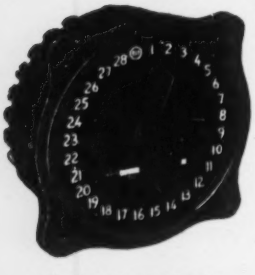
THREADED "AN" TYPE



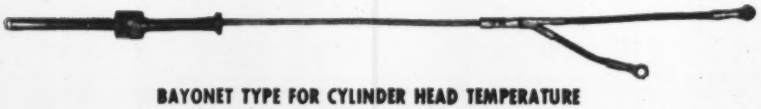
3" SIZE TO 20 POINTS



THREADED "AN" TYPE



4" SIZE TO 28 POINTS



BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

We invite inquiries on your temperature measuring problems.

THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

NAUGATUCK, CONNECTICUT

For more information circle 9 on inquiry card.

Trends...

Instruments and AUTOMATION

Automation will change character of nation's entire work force. Demand for technically trained men will increase—re-emphasizing present inadequacy of engineering educational effort.

Men in charge of the instruments, controllers, and computers will become the key men in automated operations. Instrument departments which started as small repair facilities with less than ten men have, in a few years, grown to central control centers with personnel in the hundreds. Computers could put instrument department in charge of all plant operations, could make instrument department the systems manager.

Automatic control of aircraft, necessitated by modern speeds, is increasing responsibilities of flight engineers and ground maintenance crews. Flight engineer is becoming systems manager.

Single modern development with greatest potential is the electronic computer. Data processing computers are now changing functions of larger offices throughout U.S.; digital and analog computers are now changing methods of all design engineers. Analog computer could put working model of unit chemical processes (and complete plants) in hands of the plant operating center—the instrument department.

First Computer Clinic (New York, Nov. 30-Dec. 2) is unique opportunity for engineers, instrument departments, and operating personnel to get working demonstrations and perspective on entire field of computers—for first time. Clinic sessions will be offered by Austin (special purpose computers), Bendix (digital computers), Electronic Associates (analog computers), Goodyear Aviation (analog computers), International Business Machines (data processors and digital computers), Remington Rand (data processors and digital computers). Note complete coverage of all basic types. Attendance has registered from all parts of U.S. for this important Clinic.

Long-term trend—watch for the autotransistor, a transistor with built-in radioactive-isotope-activated (radioactivated) power supply. The "atomic-battery-powered" transistor will be a small self-powered unit device using a minute amount of radioactive isotope. Life of unit (determined by half-life of isotope) will be decades.

The "growth industries" (magnesium, air-conditioners, plastics, synthetic fibers, frozen foods, etc.) depend on Instrumentation more than do static industries. Therefore, Instrumentation's proportion of capital investments will continue to accelerate.

Use of graphic circuits and mechanized wiring is increasing. "Oddly enough," says one recent editorial comment, "instrument makers are setting the pace." Reasons are not odd: assembly errors are reduced, calibrations are more stable, instrument is more rugged, instrument market is expanding, instrument makers are progressive.

"Automation is probably the century's greatest contribution to the reduction of man's burden," says Dr. M. J. Kelly, President of Bell Telephone Labs at AISI general meeting in New York. However, he said, "advances will not come as a revolution in present methods but rather as a hard-earned step-by-step evolution."

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

New Basic Transducer -- the "T-42 Ionization Transducer"

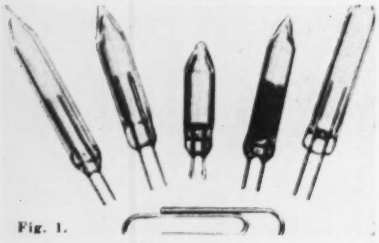
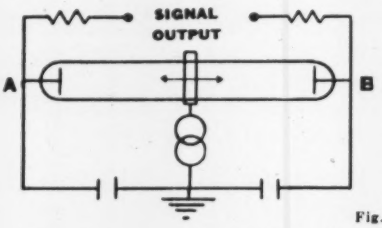


Fig. 1.



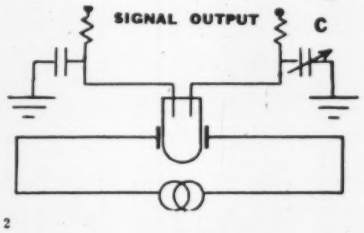


Fig. 2

PHILADELPHIA, PA.—The "T-42 Ionization Transducer," a basic transducer (Fig. 1) was unveiled at the 1st International Instrument Exposition at Philadelphia by Decker Aviation Corp., also of Philadelphia.

The "T-42 Ionization Transducer" is based on an observation made by Kurt S. Lion (Ph. D., Associate Professor of Biophysics, Massachusetts Institute of Technology) in 1938, in Frieburg, Switzerland, while engaged in experimental studies of noble-gas discharge tubes in high-frequency electric fields. Dr. Lion exposed a gas-discharge vessel containing two electrodes to a radio-frequency electric field (between the plates of a capacitor) and found that a relatively high d-c. voltage developed between the two electrodes. The magnitude of this voltage varied between -60 and +60 volts as a function of the position of the tube in the electric field.

Although the phenomenon still is not understood theoretically, the effect appears to be caused by generation of space charges within the glow discharge, and the pickup of these charges by the electrodes acting as probes. Any slight assymetry of the electrodes, due to an unbalanced field or any other cause, causes an output voltage. Voltages of several hundred volts have been observed; movement of the discharge tube of 0.001 mm. produces an output voltage of greater than two volts.

Two basic configurations are shown in Fig. 2. At the left, the gas is ionized by a ring electrode. An output voltage, developed between points A and B, is linear with relative motion of ring electrode and tube.

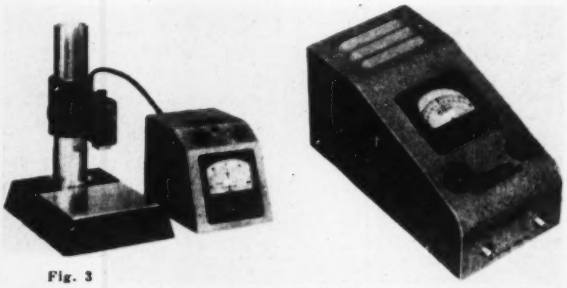


Fig. 3

At the right, the gas is ionized by external electrodes. An output voltage can be developed by either (1) relative motion of electrodes and tube, or (2) change in capacitance C. Motions in the order of 10^{-6} inch, or capacitance changes in the order of 10^{-15} farads (0.001 uuf.) produce outputs (with these configurations) suitable for use without voltage amplification.

The transducer has been used for pressure measurement (high and low pressures), humidity measurement, dielectric investigation, acceleration pickups, linear and angular displacement pickups, conductivity meters, thermometry, tachometers, seismographs, capacitance meters, etc.

Fig. 3 (left) shows a micrometer using the "T-42" transducer; sensitivity is one millionth inch per division, with no contact with work piece. Fig. 3 (right) shows a pressure indicator with resolution of 1 micron Hg (pressure is used to effect capacitance change).

Calibration of Vibration Pickups and Accelerometers

WASHINGTON, D. C.—Widespread use of vibration pickups has introduced calibration problems. Several methods have been developed at the National Bureau of Standards for such calibration.

The Chatter Accelerometer

The "chatter" principle was first described by Sir William Bragg in 1919. The accelerometer based on this principle (Fig. 1) is a device in which a loose mass on a vertically vibrating surface bounces or "chatters" when the peak acceleration of the sinusoidal motion exceeds ± 1 g. Using an improved accelerometer developed by C. W. Kis-

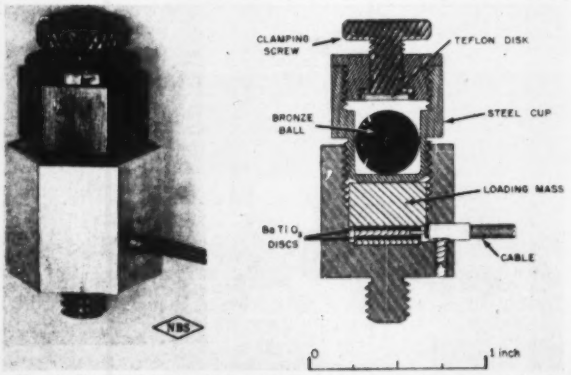


Fig. 1. The NBS-33-24 chatter accelerometer determines accurately the peak value of a sinusoidal acceleration slightly in excess of one g.

NOW.. OHMITE® OFFERS

RESISTORS TO MEET MIL-R-26B CHARACTERISTICS G, F, AND "V"

(HIGH-TEMPERATURE—350° C—CHARACTERISTIC)

IN A WIDE RANGE OF SIZES AND RESISTANCE VALUES

PATENTED, ALL-WELDED CONSTRUCTION!

TAB-TERMINAL TYPE
Characteristics G, F, and V

Style	Over-all length	Diameter	*Watts	††Watts
RW-29	1-3/4"	1/2"	8	11
RW-30	1"	19/32"	8	11
RW-31	1-1/2"	19/32"	10	14
RW-32	2"	19/32"	12	17
RW-33	3"	19/32"	18	26
RW-34	3"	29/32"	30	43
RW-35	4"	29/32"	38	55
RW-36	4"	1-5/16"	60	87
RW-37	6"	1-5/16"	78	113
RW-38	8"	1-5/16"	110	159
RW-47	10-1/2"	1-5/16"	145	210

FERRULE-TERMINAL TYPE
Characteristics G, F, and V

Style	Over-all length	Diameter	*Watts	††Watts
RW-10	11-7/16"	1-5/16"	140	203
RW-11	9-5/8"	1-5/16"	116	168
RW-12	7-7/16"	1-5/16"	86	125
RW-13	5-1/8"	1-1/16"	50	72
RW-14	4-7/16"	1-1/16"	40	58
RW-15	2-15/16"	3/4"	20	29
RW-16	2-3/8"	3/4"	14	20

FLAT TAB-TERMINAL TYPE
(Stack Mounting) Characteristic G

Style	Over-all length	Width of Core	Thickness of Core	†Watts
RW-20	2-1/2"	1-3/16"	1/4"	15
RW-21	3-1/4"	1-3/16"	1/4"	22
RW-22	4-3/4"	1-3/16"	1/4"	37
RW-23	6"	1-3/16"	1/4"	47
RW-24	7-1/4"	1-3/16"	1/4"	63

AXIAL-TERMINAL TYPE
Characteristics G and V

Style	Length of Core**	Diameter	†Watts	††Watts
RW-55	1-3/8"	5/8"	5	7
RW-56	2"	5/8"	10	14

*Watts free air MIL Characteristic "F" or "G" **2-1/2" wire leads
†Watts free air MIL Characteristic "G"
††Watts free air MIL Characteristic "V"

EVEN RESISTORS WITH THE FINEST WIRE SIZE (.00175) MEET THE REQUIREMENTS OF MIL-R-26B, CHARACTERISTIC "V"

The Ohmite resistor types shown at the left can withstand a continuous operating temperature of 350° C—the high temperature requirement of MIL-R-26B, Char. "V". These resistors also meet characteristics "G" and "F"—passing severe moisture-resistance and thermal-shock tests . . . withstanding sustained vibration applied for five continuous hours . . . and satisfying the requirements of many other tests.

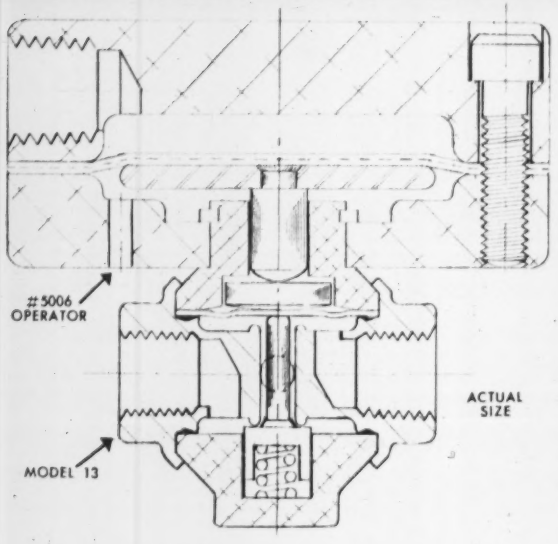
The Ohmite line of wire-wound resistors is the most extensive on the market. Ohmite also has the most complete line that meets MIL-R-26B specifications. Specify resistors from Ohmite's wide range of types, sizes, and resistance values for your MIL-R-26B requirements and other tough jobs.

OHMITE MANUFACTURING COMPANY
3615 Howard Street Skokie, Illinois
(Suburb of Chicago)

OHMITE®
RHEOSTATS • RESISTORS • TAP SWITCHES

For more information circle 10 on inquiry card.

"DEMI"



PACKLESS
3 WAY VALVE

Your requirements for an economical, compact, Diaphragm-operated Packless Valve for on-off service are more than fulfilled in our "DEMI", Model 13, shown in the above design for control air service. List price is $18.72, with ¼" IPS standard porting. "DEMI" Valves can also be supplied with integral tubing connections of several well-known designs.

Standard Operators, both reverse and direct acting, are available with effective diaphragm areas from 2.5 to 15 sq. in.

For prices, in various materials and porting arrangements, inquire of our local representative in your area, or directly to our home office.

OTHER PRODUCTS MANUFACTURED

Hand Operated Valves.

Diaphragm Operated Valves.

Packed or Packless Valves.

Quick Disconnect Pipe or Tubing Couplings from 1" to 8" for vacuum or high pressure.

Machined Teflon Products.

Special Products, engineered to meet your requirements.

George W. DAHL Company
BRISTOL, RHODE ISLAND

For more information circle **11** on inquiry card.

ON THE MARCH—CONTINUED

singer of NBS, the acceleration of the shaker table to which the device is attached, as well as the chatter of the loose mass, are converted into an electrical signal which is displayed on the screen of an oscilloscope. The mathematical relationship was also derived between (1) the amount by which the peak value of the sinusoidal acceleration exceeds 1 *g* and (2) the point in the cycle at which the first bounce occurs. If this mathematical relationship is applied to the accelerometer output as observed on the oscilloscope screen, acceleration levels from about 1.01 *g* to 1.04 *g* may be set with an accuracy of approximately 0.2 percent at frequencies up to 60 cps., and with somewhat decreased accuracy up to about 150 cps. The accuracy of calibration was estimated by comparison with an optical calibration in which the peak-to-peak displacement of the chatter accelerometer was measured with a micrometer microscope. Stroboscopic illumination makes the accelerometer appear to be nearly motionless for ease of measuring displacement.

In the Bureau's chatter accelerometer, the loose mass can be clamped by a screw and prevented from chattering. The accelerometer can then be used as a secondary standard for accelerations in excess of 1 *g* at frequencies up to 1200 cps.

Steady-state Calibration

The method for steady-state calibration at high values of sinusoidal acceleration was developed by T. A. Perls and C. W. Kissinger of the NBS staff. In this method (Fig. 2)

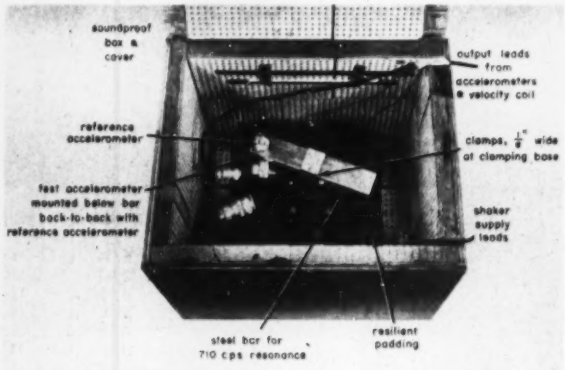
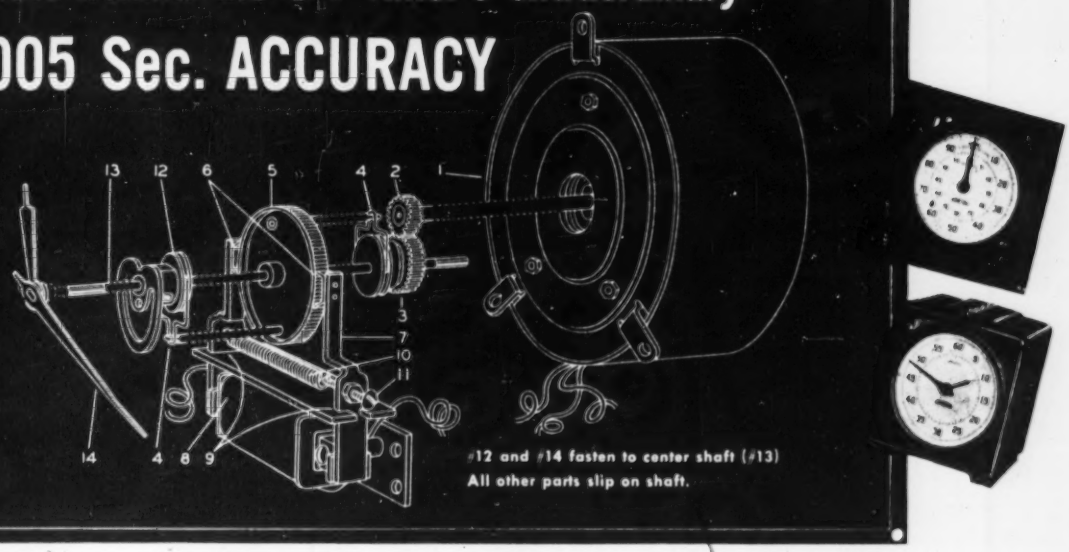

soundproof box & cover
output leads from accelerometers & velocity coil
reference accelerometer
clamps, ½" wide at clamping base
test accelerometer mounted below bar back-to-back with reference accelerometer
shaker supply leads
steel bar for 710 cps resonance
resilient padding

Fig. 2. Instrument for steady-state calibration of vibration pickups and accelerometers at high values of acceleration. A steel bar with a vibration pickup clamped to one end is driven at its resonant frequency at acceleration up to 1090 g.

a steel bar is clamped to the head of an electrodynamic shaker at its center point, so that both ends of the bar are free. The accelerometer being tested is clamped back-to-back with an NBS-33-14 secondary-standard accelerometer at one end of the bar, and a balancing weight is fastened to the other end, if needed. The whole system is driven at its resonant frequency by a 70-watt amplifier. Steady-state accelerations have been measured with this system up to 1090 *g*, zero to peak, at 374 cps. When the resonant bar was additionally loaded with a 40-gram test accelerometer, accelerations up to 665 *g* were attained. In comparison, if the steel bar had not been used and the accelerometer had been mounted directly on the shaker head, the maximum attainable acceleration would have been only 50 *g*. The elastic properties of the bars used in the tests limit the maximum steady-state vibratory amplitudes attainable by this method.

In this method, the armature of the electrodynamic shaker is part of the resonating system, and its amplitude

Facts behind the S-1 Timer's extraordinary
.005 Sec. ACCURACY



Formula S-1 ***Expensive high torque, ball bearing motor, low inertia of moving parts, high proportion of precision and ground parts, no thrust bearings as found in ordinary clutches.***

● High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field . . . runs continuously to eliminate starting error.

● Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.

● Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with 314 tiny teeth in its periphery.

● To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places . . . control disc position to under ½ of a degree (1/720 second).

● Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.

● Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.

● Second friction clutch (#12) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

"Gentlemen . . . Let me give you the formula for our astounding final accuracy of .005 sec. obtained with our D-C clutch S-1 Timer."

STANDARD SINCE 1884

To Split the Split Second with ACCURACY, Take a Minute Now and Send Us This Coupon

The STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET • SPRINGFIELD 2, MASS.

PRECISION TIMERS • PIPELINE NETWORK ANALYZERS
LABORATORY PANELS • CHRONO-TACHOMETERS

THE STANDARD ELECTRIC TIME COMPANY
93 Logan Street • Springfield 2, Massachusetts
Gentlemen: Please send me complete Engineering Data on the S-1 Timer.

Name _____

Firm _____

Street _____

City _____ State _____

For more information circle **12** on inquiry card.

CUSTOM BUILT

Electrical Enclosures

by KIRK AND BLUM

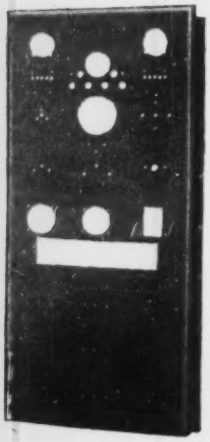
KIRK & BLUM can produce any type of metal enclosure . . . quickly and economically.

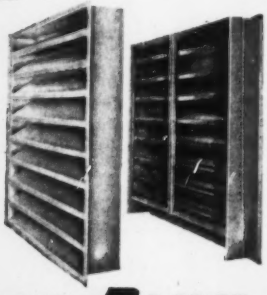
Facilities for fabrication of sheet steel, plate, light structurals, stainless, aluminum, monel and other alloys.

Whatever your needs, send prints to Kirk & Blum for prompt quotation. For literature on electrical enclosure fabrication facilities and experience, write to: The Kirk & Blum Mfg. Co., 3111 Forrer Street, Cincinnati 9, Ohio.

CONTRACT MANUFACTURING FACILITIES FOR

- Control Desks
- Instrument Panels
- Boiler, Turbine, Generator Panels
- Power Distribution, Control Panels
- Switch Gear Housings
- Cubicles • Machine Bases
- Weatherproof Housings
- Breechings • Air Ducts
- Transformer Enclosures
- Stacks • Casings • Hoppers





KIRK AND BLUM

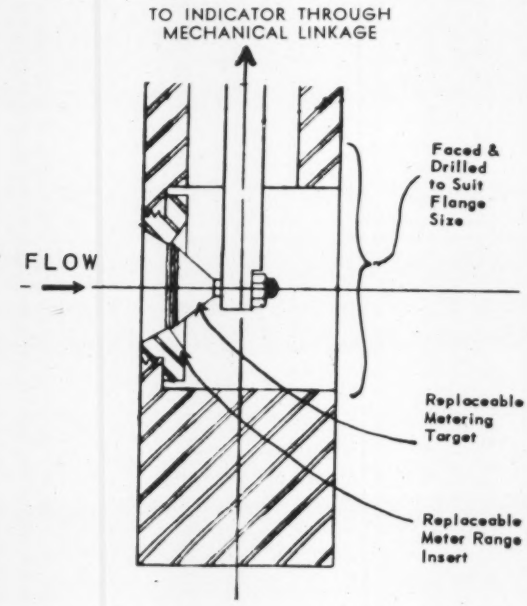
METAL FABRICATION

For more information circle 13 on inquiry card.

of motion at resonance is proportional to the amplitude at the ends of the bar. This mode of operation makes it possible to determine that the output of an NBS-33-14 accelerometer from 25 to 1090 *g* at 874 cps. is proportional, within 2 percent, to the output of a velocity pickup built into the armature of the shaker.

New Flowmeter Concept

PHILADELPHIA, PA.—Unique flow-measuring element was revealed at 1st International Instrument Exposition, Philadelphia, by DevicEngineering Co., also of Philadelphia. The "Model 1-100" element is a variable-area device in which the variable area is that between the "metering


TO INDICATOR THROUGH MECHANICAL LINKAGE
Faced & Drilled to Suit Flange Size
FLOW
Replaceable Metering Target
Replaceable Meter Range Insert

target" and tapered "meter range insert." Motion of target (linear with flow) is transmitted mechanically through a bellows seal to a dial indicator with a linear flow scale. Thus meter combines variable-area features (35:1 rangeability, linear scale, constant pressure drop, low viscosity-sensitivity) with orifice features (low cost, simple installation). Unit installs in line like an orifice; models are available with scales (max. capacity) from 2.5 to 2000 gpm. water, and from 8 to 6000 scfm. air.

Color Control

SCHENECTADY, N.Y.—New frontiers in pictorial artistry have been opened with the introduction of a new concept in filters, G-E's "Variable Color Filter Type PA-1," and a new "Color Control Meter." The filter permits control of color balance, contrast, color saturation, sky brightness, and specular reflections.

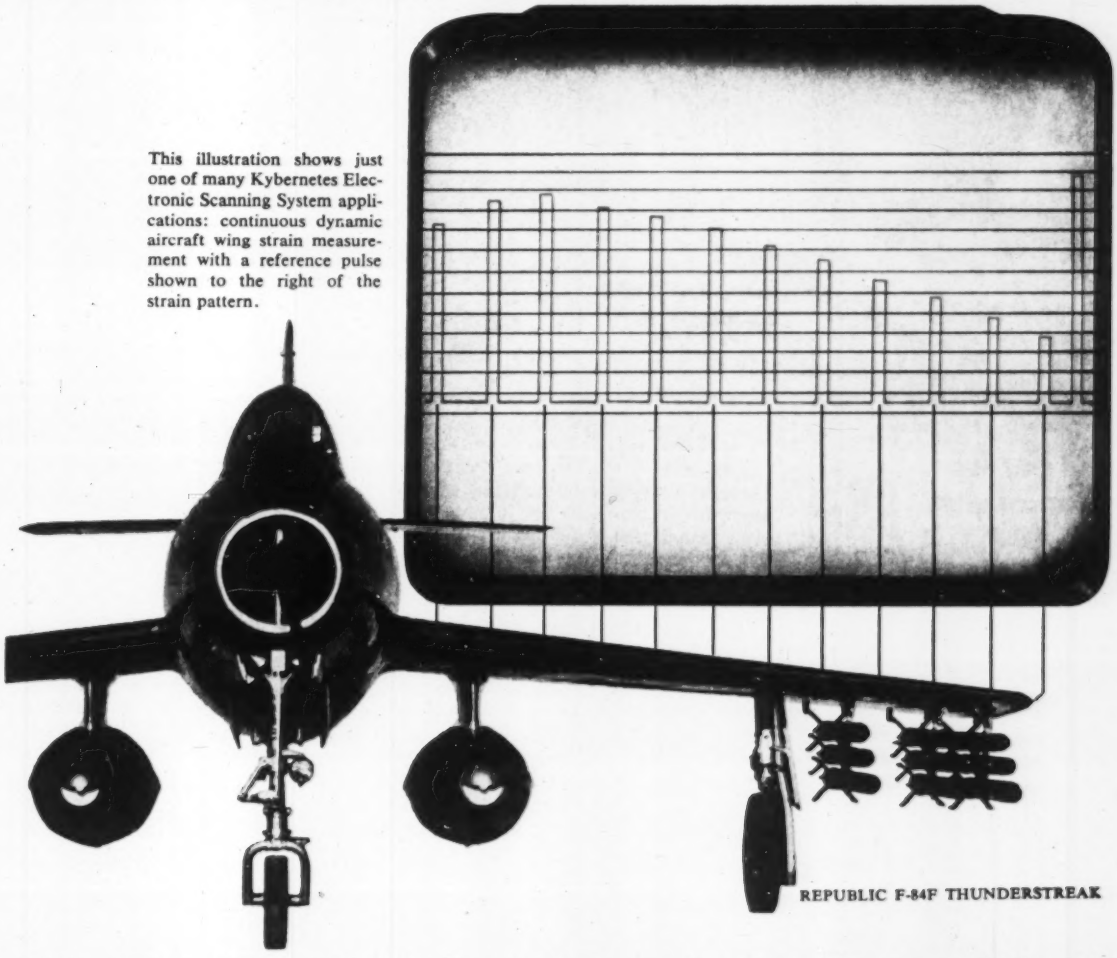
The color correction of the Variable Color Filter can be predetermined by use of the GE "Color Control Meter," shown in use in the illustration. This measures the red/blue balance of natural light and, thus, the correct filter.

This new filter contains two essential parts. The rear element is a dichroic filter which appears yellow when the incident light is polarized along one of its axes. The color

PROVEN!

Continuous Dynamic Strain Measurement

This illustration shows just one of many Kybernetes Electronic Scanning System applications: continuous dynamic aircraft wing strain measurement with a reference pulse shown to the right of the strain pattern.



REPUBLIC F-84F THUNDERSTREAK

Another application achievement of the Kybernetes Electronic Scanning System!* This high speed scanning system permits a graphic display of the results of a load test. The strain pattern on an airplane wing appears on the face of an oscilloscope tube as the test is made.

Completely electronic, the Kybernetes Scanning System scans each of any number of points 60 times or more per second. You secure uninterrupted scanning, continuous protection and alarm indication throughout logging, recording, and point reading. There is continuous qualitative and quantitative scope display of any variable. Other readout and alarm devices available if oscilloscope presentation is not desired.

The Kybernetes Electronic Scanning System is readily miniaturized and JANized for airborne and other specialized uses.

You may use the Kybernetes Electronic Scanning System to monitor temperature, flow, level, pressure, viscosity, pH, concentration, conductivity, radiation, gas analysis, as well as for dynamic strain measurement.

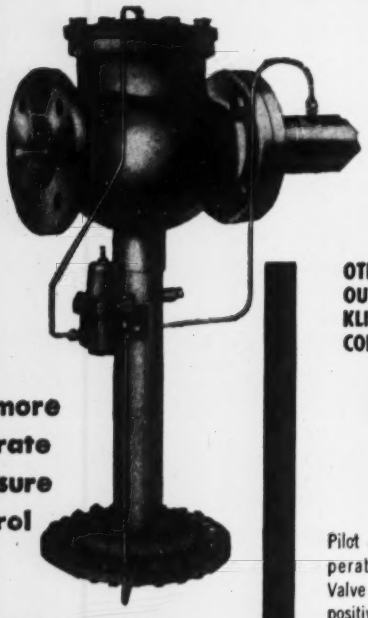
The Kybernetes Electronic Scanning System will be demonstrated at the First International Automation Exposition, November 29th to December 2nd, Booth 119.

For specific information applicable to your own monitoring requirements, write today.

The KYBERNETES Corporation • DIVISION OF SELF WINDING CLOCK CO., INC. (* PATENT PENDING) ©1954

1100 RAYMOND BOULEVARD, NEWARK 5, NEW JERSEY (OPPOSITE PRR STATION)

For more information circle **14** on inquiry card.



for more accurate pressure control

the NEW

Klipfel

PILOT-OPERATED

REDUCING VALVE

No. 933

QUICK ACTING FOR MINIMUM PRESSURE VARIATION

When you need "on-the-button" steam pressure reduction, specify the new Klipfel Pilot-Operated Reducing Valve.

Although extremely sensitive, its simple operation insures trouble-free service. Downstream pressure is sensed by the diaphragm of the pilot valve. The pilot valve uses upstream pressure to open the main valve if downstream pressure is too low; if too high, pressure is bled off to partially close main valve.

The next time you order a reducing valve, get the new standard for accurate control and low cost operation . . . Klipfel No. 933 Reducing Valve. Detailed literature on request.

Klipfel VALVES, INC.
1070 Lincoln Ave.
Hamilton, Ohio

OTHER OUTSTANDING KLIPFEL CONTROLS:

No. 1549
Pilot - operated Temperature Regulating Valve . . . sensitive, positive control for high pressure, larger sizes.

No. 1649
Combination Temperature and Pressure Control... single main valve with temperature and pressure control saves cost and labor!

For Quick Service!

Call your supply house or Klipfel Distributor listed in yellow pages.

Export Office—1010 Schaff Building, Philadelphia 2, Pa.

For more information circle 15 on inquiry card.

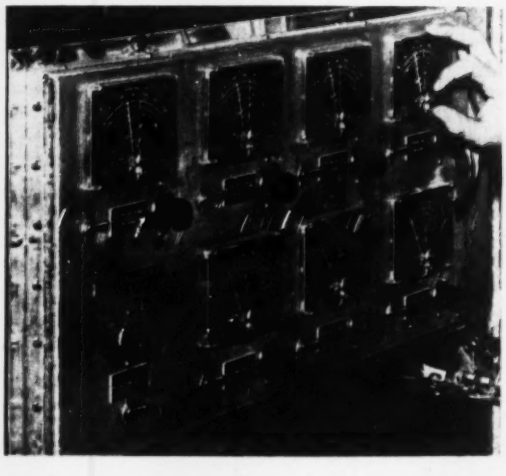
appears bluish when the incident light is polarized on the other axis at right angles to the first. When the incident light is polarized along any intermediate axis various shades of yellow to blue through neutral may be obtained.

The front element is a polarizer. The incident light on the rear element is polarized in line with the axis of this front element. As the front element is turned with respect to the rear element, the color of light transmitted by the combination varies from yellow to blue through neutral. On the front element is a scale which indicates the transmitted color as shown from the corresponding position of the reference mark on the back element. Thus the user can pre-set the desired color before placing the filter over the camera lens.

Unattended Pumping Station

TWINSBURG, OHIO.—This "Simplytrol Polypoint" at Twinsburg, Ohio monitors all critical bearings and shuts down the pipeline pumping station in event of temperature rise.

The Twinsburg station is part of a network of pipelines interconnecting refineries in Northern Ohio: it is completely automatic and runs unattended. An iron-constantan thermocouple is attached to each bearing. Temperatures are shown



ELECTRONIC TEST INSTRUMENTS

-hp- 522B Electronic Counter

IS YOUR MEASURING PROBLEM HERE?

FREQUENCY	TIME INTERVAL
Production quantities	Elapsed time between impulses
Nuclear radiations	Pulse lengths
R.P.S. and R.P.M.	Camera shutter speed
Power line frequencies	Projectile velocity
Very low frequencies	Relay operating times
Frequency stability	Precise event timing
Oscillator calibration	Interval stability
Pulse repetition rates	Frequency rates
Weight, pressure, temperature, acceleration	Phase delay

Investigate this new, low-cost all purpose *-hp-* counter

This new electronic counter can save you time and money by speeding and simplifying research and manufacturing measurements. It is a compact, low-cost, extremely versatile instrument offering you accurate frequency, period *or* time measurements. It performs all functions without extra-cost modification. Results are displayed instantly and automatically in direct-reading form. Unskilled personnel can use the instrument immediately without training.

Model 522B measures rate of occurrences from .00001 to 100,000 per second. It measures time from 10 microseconds to 27.8 hours. Counting is available over periods of 1/1,000, 1/100, 1/10, 1 and 10 seconds or multiples. Stability of time base is 5 parts per million. Time of display can be varied to any duration, counts are automatically reset, action is repetitive. Results are presented direct in cps, kc, seconds or milliseconds. Decimal point is automatically indicated.

The instrument consists of five decade counters, a wide range time base plus gating and auxiliary circuits. The unknown is applied to the counters through the gate circuit. For frequency measurement this circuit remains open for a precise interval controlled by an oven-housed quartz crystal.

-hp- 522A Electronic Counter

For applications where wide-range frequency and period measurements are desired. Frequency counting facilities are identical with 522B, except gate time for frequency measurement is 1 second or multiples, and standard frequency counted for period measurement is 100 kc. Decimal point and time interval measuring circuits are omitted. $775.00

Data subject to change without notice. Prices f. o. b. factory

SPECIFICATIONS—MODEL 522B

FREQUENCY MEASUREMENTS:

Range: 10 cps to 100 kc.

Accuracy: ± 1 count ± stability (5/1,000,000 per week).

Registration: 5 places. Output pulse available to actuate trigger circuit for mechanical register to increase count capacity.

Gate Time: .001, .01, .1, 1, 10 seconds. Extendable to multiples of 1 or 10 seconds by manual control.

Display Time: Variable .1 to 10 seconds in steps of gate time selected. Display can be held indefinitely.

PERIOD MEASUREMENTS:

Range: .00001 cps to 10 kc.

Accuracy: ± .03% ± stability (for measurements over a 10 cycle period).

Gate Time: 1 or 10 cycle of unknown. Extendable to any number of cycles by manual control. (For frequencies under 50 to 60 cps.)

Standard Freq. Counted: 1, 10, 100 cps; 1, 10, 100 kc; or external.

TIME INTERVAL MEASUREMENTS:

Range: 10 μsec to 100,000 seconds (27.8 hrs.)

Accuracy: ± 1/std. freq. counted ± stability.

Trigger Slope: Pos. or neg. on start and/or stop channels.

Trigger Amplitude: Continuously adjustable on both channels from −100 to +100 volts.

Standard Freq. Counted: 1, 10, 100 cps; 1, 10, 100 kc; or external.

Price: $900.00 f.o.b. factory.

Write for complete details

HEWLETT-PACKARD COMPANY

2707C PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

SALES REPRESENTATIVES IN ALL PRINCIPAL AREAS

Export Division: 275 Page Mill Rd., Palo Alto, Calif., Cable "HEWPACK"

Instruments for Complete Coverage

For more information circle **16** on inquiry card.

THESE FLUIDS ARE DIFFICULT TO PUMP

ACETALDEHYDE
ACETONE
FORMALDEHYDE
FREON
MERCAPTANS
MERCURY
MOLTEN METALS
NAPHTHALENE (Molten)
NITRIC ACID
PHOSPHORIC ACID
SODIUM CYANIDE
SULFUR DIOXIDE
TRINITROCHLOROBENZENE
VINYLIDENE CHLORIDE
CHLOROSULFONIC ACID
CHROMIC ACID
HYDROBROMIC ACID
NITRIC ACID
OLEUM
OXALIC ACID
PROPIONIC ACID
SULFURIC ACID
IODINE
BENZOLCHLORIDE
BENZOLTRICHLORIDE
LIQUID BROMINE
CHLORACETIC ACID
DILUTE ACIDS
ALUMINUM SULFATE
DIATOMACEOUS EARTH SLURRY
FERRIC SULFATE
SODIUM HYPOCHLORITE
SALT SOLUTIONS
SODIUM SILICOFLUORIDE
HYDROGEN PEROXIDE
HYDROCHLORIC ACID
BROMINE TRIFLUORIDE
CHLORINE
CHLORINE TRIFLUORIDE
FLUORINE GAS
HYDROFLUORIC ACID
HYDROGEN CYANIDE
HYDROGEN FLUORIDE
FLUORINE
SULFUR DICHLORIDE

THEY ARE HANDLED SUCCESSFULLY BY THE Lapp PULSAFEEDER

PISTON-DIAPHRAGM CONTROLLED-VOLUME CHEMICAL PUMP

Not competitive with any pump of more conventional design, the Lapp PULSAFEEDER is a highly specialized, precision, custom-built machine suited to a wide variety of special applications involving controlled-volume pumping of fluids.

Basic feature of Lapp PULSAFEEDER design is its combination of reciprocating piston action (to provide the accuracy of positive displacement) with an hydraulically balanced diaphragm which isolates material being pumped from working pump parts—and, of course, eliminates need for stuffing box or running seal.

Control of pumping rate is achieved at constant pumping speed; variable flow results from variation in piston stroke length—adjustable by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measureable processing variable.

Justification for this specialized premium construction is evident in the many, and varied, applications in which Lapp PULSAFEEDER alone is able to perform satisfactorily. In fact, the economies of continuous processing, automatic proportioning, feeding and filling in many operations are possible only because of the unusual characteristics and peculiar advantages of Lapp PULSAFEEDER.

In general, use of the Lapp PULSAFEEDER is indicated for continuous (or intermittent) pumping, at accurately controlled volume, of fluids which cannot be satisfactorily exposed to conventional pistons, cylinders and stuffing box packing—because of the corrosive action of chemicals being handled and/or need for protection of product against contamination.

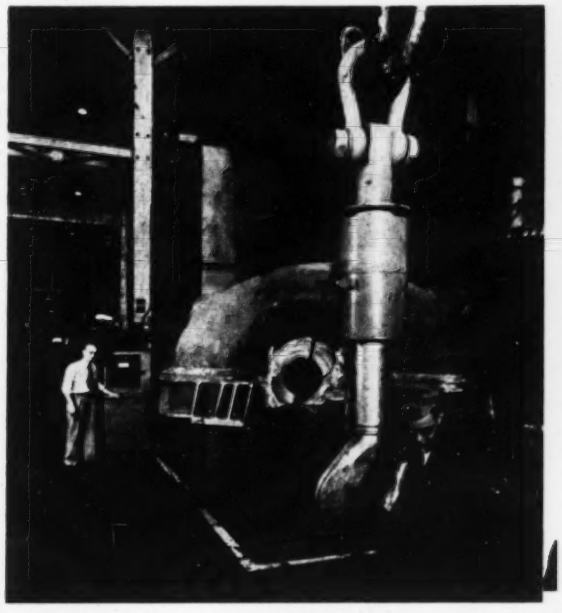
Lapp Bulletin 440 shows typical applications and flow charts. It describes and lists specifications of models over a wide range of capacities and special constructions. Also included is an Inquiry Data Sheet, from which we can make specific engineering recommendations for your processing requirement. For your copy write Lapp Insulator Co., Inc., Process Equipment Div., 377 Wilson St., Le Roy, N.Y.

For more information circle 17 on inquiry card.

directly on the "Simplytrol" scale; the safety trip point is set just above the normal operating temperatures. Contacts close in case of temperature rise and shut down the station. Other controls manipulate valves to immediately bypass this station. The shutdown is signaled to a central control station. "Simplytrol" contact meter-relays are made by Assembly Products, Inc., Chagrin Falls, Ohio.

Crane Scale

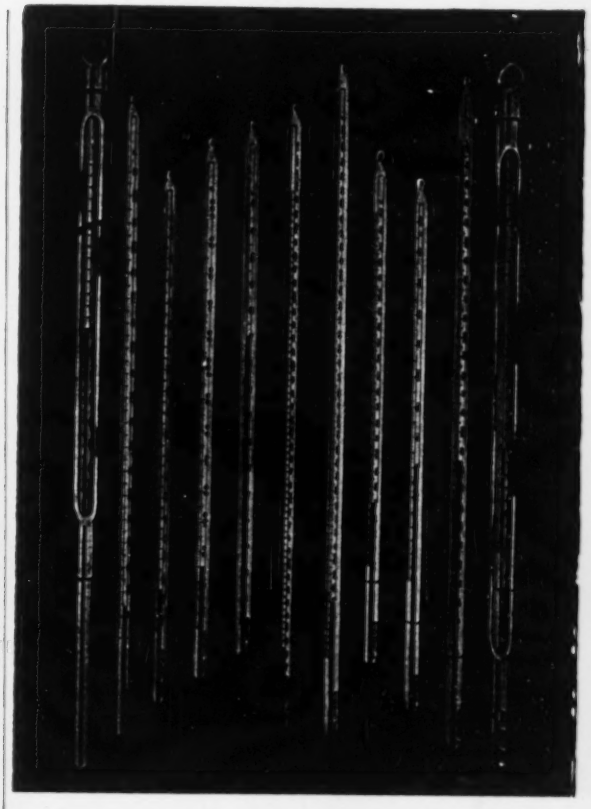
WEST LYNN, MASS.—Costs of weighing the huge parts, assemblies, and housings of turbines, generators, and propulsion gears before shipment from General Electric Com-



pany's River Plant in West Lynn, Mass., were reduced 10 to 12 percent following installation of a Baldwin SR-4 electric crane scale of 50-ton capacity. Time savings of at least 20 percent are reported for an average of eight weighings per day, which have ranged to date between 850 and 68,000 pounds. Weighing accuracy is within 0.2 percent above 15 tons. Scale can be read to 50 lbs.

Aluminum Nameplates

CENTERBROOK, CONN.—The R. W. Cramer Co., Inc., of Centerbrook, manufacturers of precision electrical timing devices, are now using "Metal-Cals" to label their products. "Metal-Cals" are anodized, etched aluminum, made by the C & H Supply Company of Inglewood, California. Backed by a pressure-sensitive adhesive, "Metal-Cals" are easily applied to any smooth, curved, or flat surface without screws or rivets.



Pre-Tested Dependability

The Standard of MOELLER Accuracy for more than four generations

There is no guess work when you use Moeller Etched Stem Thermometers. Each instrument is designed to fit individual testing problems—built to give you lasting satisfaction—guaranteed through factory pre-tested methods with the scientific thoroughness that assures perfection in all Moeller products.

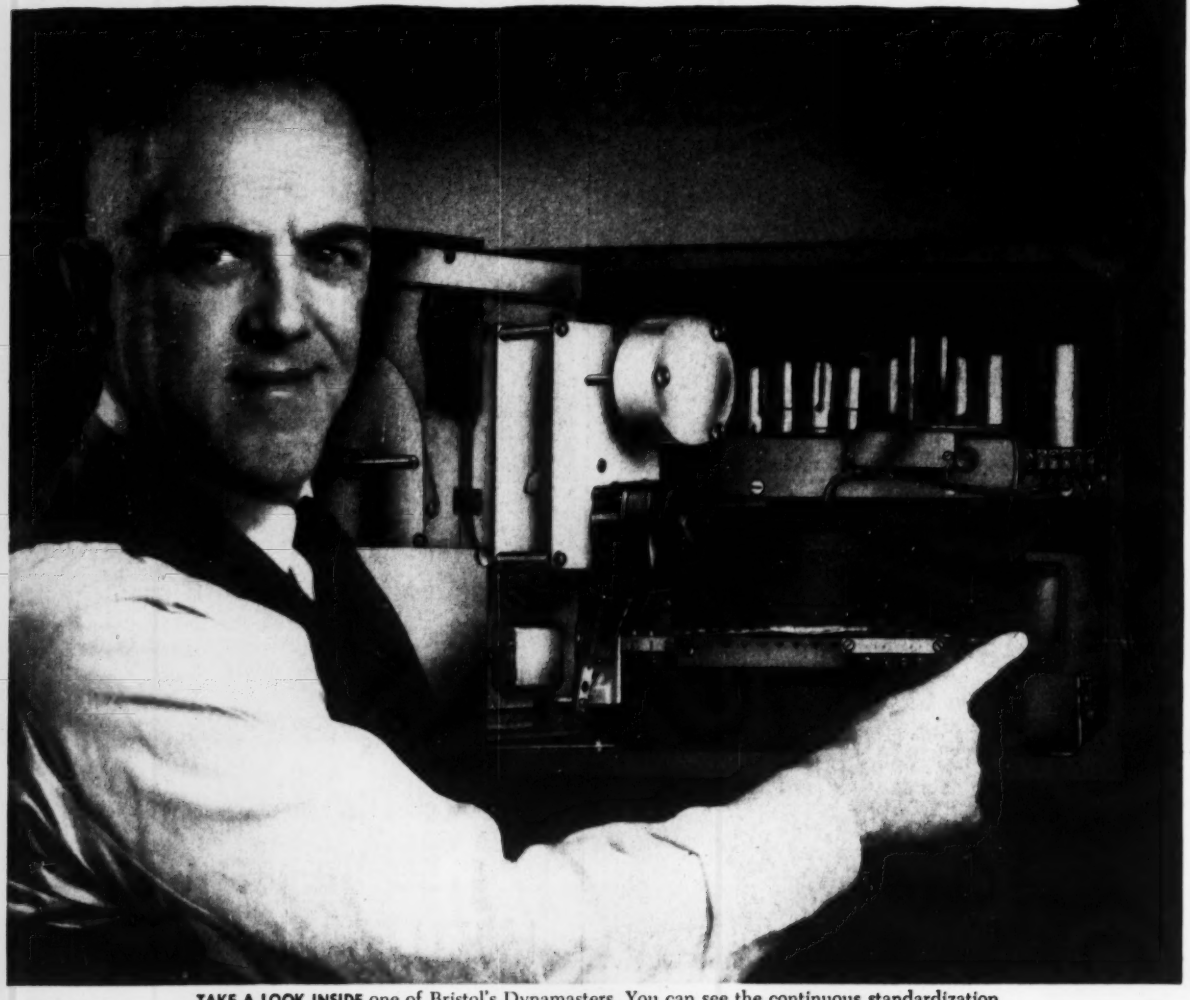
Let Moeller solve your temperature indicating recording and testing problems, Now!

Send for catalogs and literature on

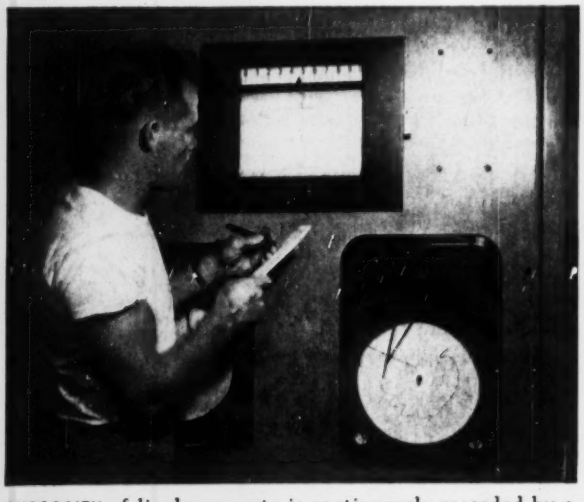
INDUSTRIAL, LABORATORY AND RECORDING THERMOMETERS
VACUUM GAUGES • HYGROMETERS
HYDROMETERS • PSYCHROMETERS
AND MARINE SPECIALTIES

MOELLER
INSTRUMENT COMPANY
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL



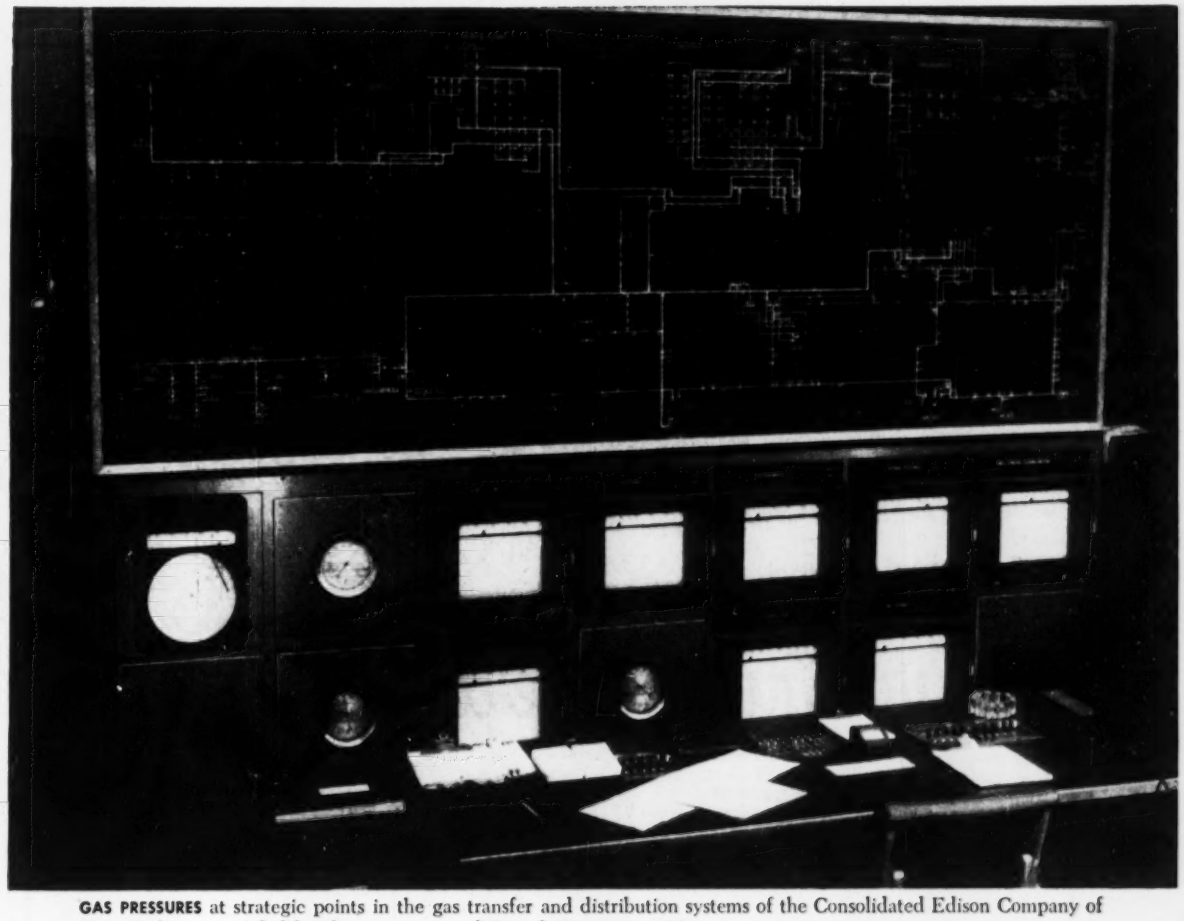
TAKE A LOOK INSIDE one of Bristol's Dynamasters. You can see the continuous standardization unit that eliminates need for dry cells and any interruptions in operation for standardization.



VISCOSITY of linoleum paste is continuously recorded by a Dynamaster Consistancy Recorder at large floor covering plant.

DYNAMASTER pH RECORDER and Bristol pH controllers guard purity of water supplied to large drug manufacturing plant.

For more information circle 19 on inquiry card.



GAS PRESSURES at strategic points in the gas transfer and distribution systems of the Consolidated Edison Company of New York are recorded by these easy-to-read Bristol Dynamaster Metameter receivers.

Measures any variable that can be translated into an electrical quantity

• Bristol's Dynamaster Potentiometers have earned a world-wide reputation for accuracy and dependability in recording, indicating and controlling temperature, pH, speed, voltage, power, current, resistance, smoke density, strain – the list could go on and on.

Behind this reputation is 65 years of instrument-making research and experience – all aimed at making Bristol instruments as precise and trouble-free as humanly possible.

One result of this research is our new No-Batt continuous standardization system, which is used in Dynamaster Potentiometers and Pyrometers. With continuous standardization eliminating the need for dry cells, the potentiometer is free to continuously measure, record and control. No time out is required for periodic standardization.

And all Dynamasters are "human-engineered", making them easier to read and clearly visible at greater distances. Simplified construction, fast operation, fewer moving parts are all achieved through Bristol's "human engineering".

Get the whole story on these rugged, precision instruments. Write today for free 36-page bulletin P1245. The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut. 4.10

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **19** on inquiry card.

SWARTWOUT

Flush Diaphragm Pressure Transmitter

- no heat jacketing
- no stagnant pressure lines
- no fluid seals

The new Swartwout P3T pressure transmitter obsoletes ordinary transmitters with stagnant pressure lines . . . that have to be heat jacketed by steam or other media.

That's because the P3T *measuring diaphragm fits flush with the inside of the process pipe.* There's no effect from temperature changes . . . no flow restriction.

If your process requires measurement of pressures in polymers, asphalts, slurries, molten metals or viscous fluids . . . in temperatures to 300° C and higher . . . with sensitivity of .005% . . . reproducibility of .1% . . . accuracy of 1%—then get full information on the Swartwout P3T Flush Diaphragm Pressure Transmitter. And look into the Swartwout Autronic System—the all-electronic process control system that is setting new standards of accuracy, simplicity, maintenance and cost.

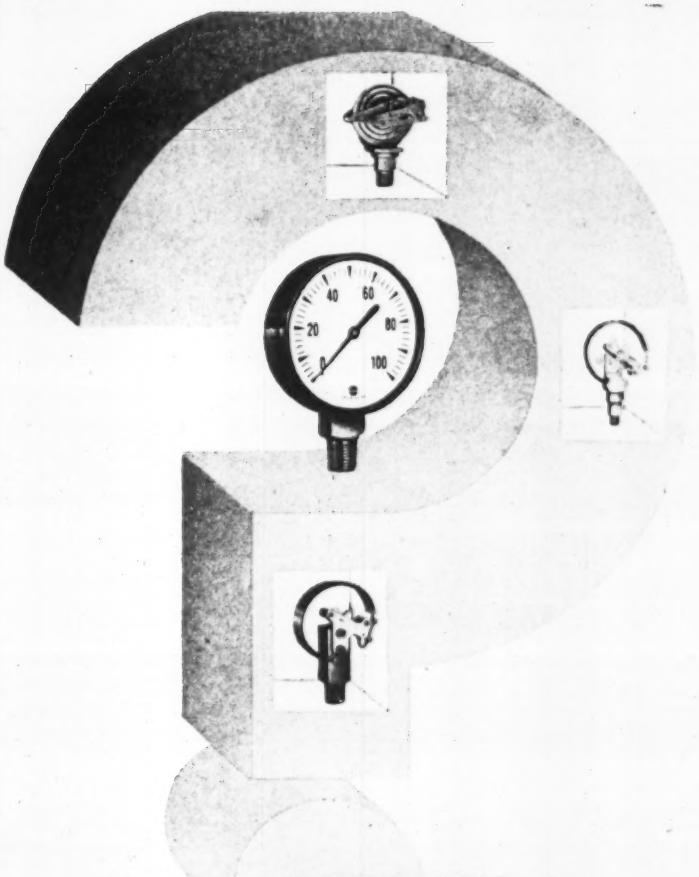
Request Bulletin A-713

Swartwout *Autronic* **CONTROL SYSTEM**

AA-428

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **20** on inquiry card.



is there a "STOCK" answer to your "SPECIAL" gauge problems?

There may very well be, because USG manufactures and stocks more than 200,000 standard gauges and a complete line of gauge components to meet practically every pressure sensing and indicating requirement.

Chances are that, with slight modification, a stock gauge will fulfill your very needs . . . eliminating the expense of special gauge design, engineering and production. USG's special background, experience and resources are ready to assist you with all problems relating to gauges or other pressure actuated devices.

A call to your nearest USG District Office, or, a letter to us at Sellersville is all that you need to determine whether we can supply a "standard" from stock . . . or, whether your application requires a "special"

UNITED STATES GAUGE USG *Gauge Headquarters* *for over 50 years*

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

USG'S RESOURCES HELP DESIGN ENGINEERS MATCH SPECIFICATIONS

Performance and price are two factors every design engineer must consider carefully when specifying gauges.

Most engineers know of USG's record of leadership in gauge design and precision engineering—for over 50 years USG has been designing and producing gauges for more Original Equipment Manufacturers than any other instrument company in the world.

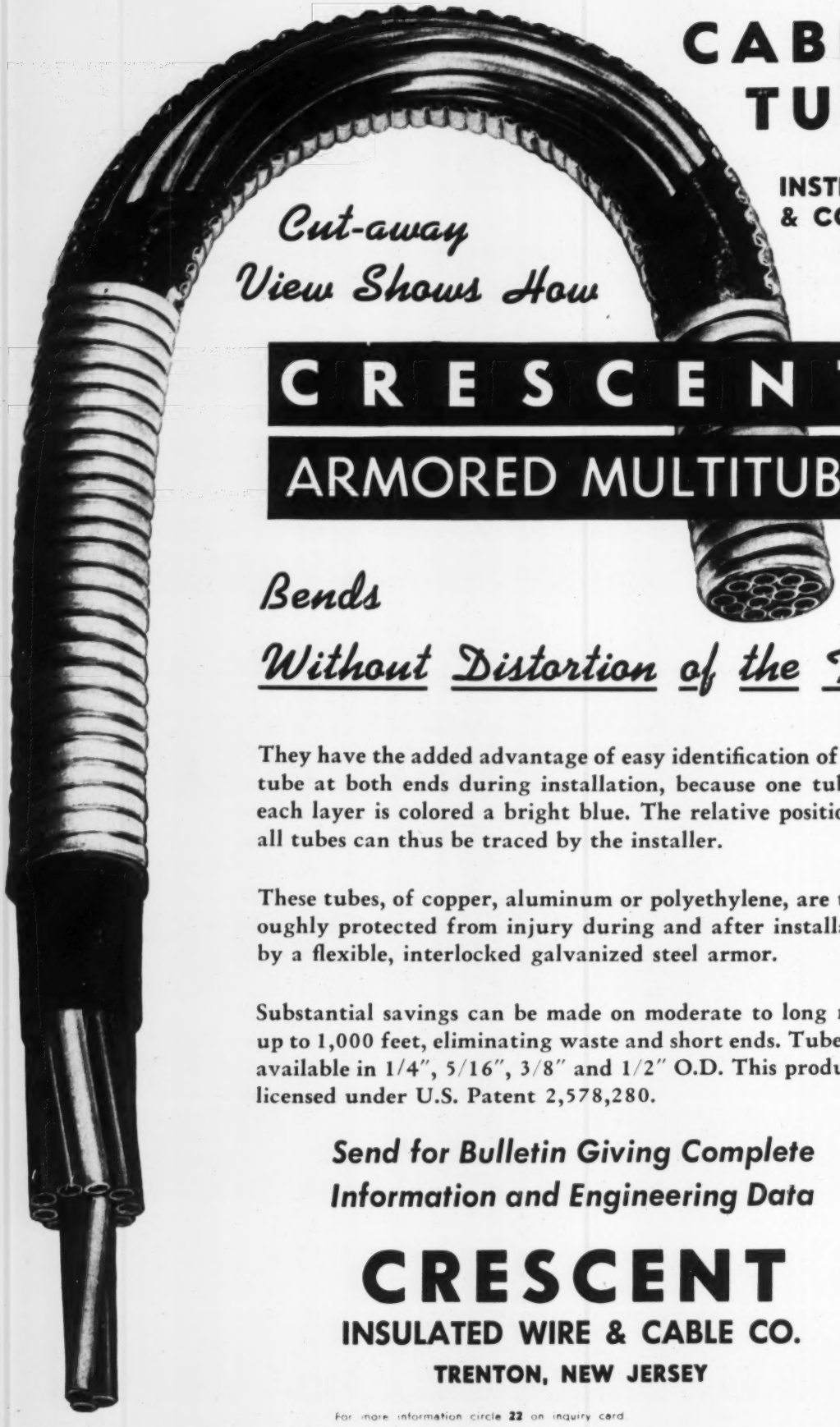
Many engineers don't know, however, that USG maintains the world's largest stock of gauge components to meet practically any pressure sensing device or pressure actuator application. These components are stocked by USG *specifically to eliminate expensive special production.*

In addition to the components for special gauge designs, USG inventories over 200,000 standard gauges in a variety of types, sizes and ranges for practically every industry application. Many stock gauges carried by USG are expensive special production items with other gauge manufacturers.

USG provides highest quality gauges at competitive prices because its facilities are economically integrated for large volume, quality controlled production. Gauge for gauge—in every application and classification—*in every price class*—USG has more to offer than any other make!

Above, a portion of USG's Research Laboratory. Here constant testing of materials under customer operating conditions assures optimum efficiency and long gauge life.

For more information circle **21** on inquiry card.



CABLED TUBES

for INSTRUMENTS & CONTROLS

Cut-away View Shows How

CRESCENT ARMORED MULTITUBE

Bends Without Distortion of the Tubes

They have the added advantage of easy identification of each tube at both ends during installation, because one tube in each layer is colored a bright blue. The relative position of all tubes can thus be traced by the installer.

These tubes, of copper, aluminum or polyethylene, are thoroughly protected from injury during and after installation by a flexible, interlocked galvanized steel armor.

Substantial savings can be made on moderate to long runs, up to 1,000 feet, eliminating waste and short ends. Tubes are available in 1/4", 5/16", 3/8" and 1/2" O.D. This product is licensed under U.S. Patent 2,578,280.

Send for Bulletin Giving Complete Information and Engineering Data

CRESCENT

INSULATED WIRE & CABLE CO.

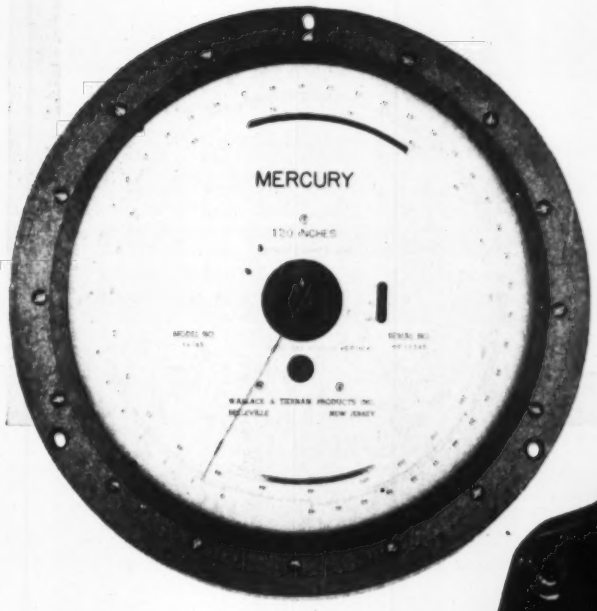
TRENTON, NEW JERSEY

For more information circle **22** on inquiry card

PRECISION PRESSURE MEASUREMENT

of Gauge Pressure, Vacuum or Differential Pressure

Precision Dial Manometer Type FA-145



Accuracy:
1 part in 1000 over full scale.
Sensitivity:
1 part in 10,000 in *all* ranges.
Ranges:
0 to 120 inches of water (min.)
0 to 250 inches of mercury (max.)
Other intermediate ranges available.
Scale Length:
45 inches.
Dial Diameter:
8½ inches.

Precision Low Pressure Gauge Type FA-141

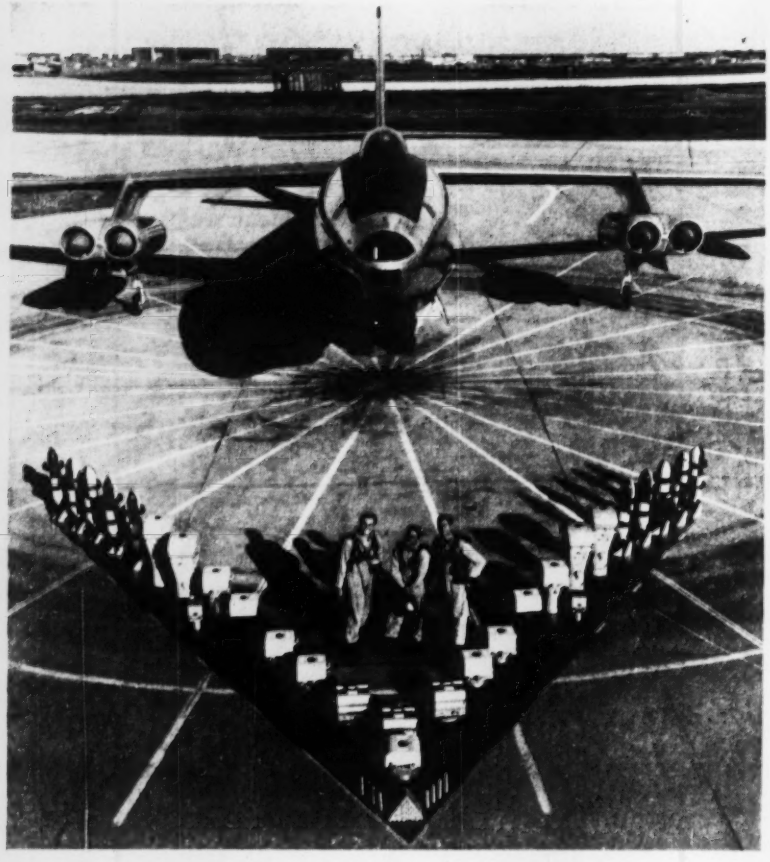
Accuracy:
1 part in 300 over full scale.
Sensitivity:
1 part in 500 in *all* ranges.
Ranges:
0 to 10 inches of water (min.)
0 to 400 inches of water (max.)
Other intermediate ranges available.
Scale Length:
7 or 16 inches.
Dial Diameter:
2¾ or 6 inches.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST. BELLEVILLE 9, N. J.
In Canada Wallace & Tiernan, Ltd. Toronto

For additional data, write for Publication TP-30-A and TP-27-A

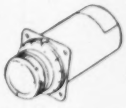
A-101

SPLIT SECOND TIMING
AT SPECTACULAR SPEEDS
with ***ABRAMS Intervalometers***



Aerial photographic equipment coordinated for use with the Boeing RB-47E. With the plane and crew are shown, seven types of cameras, cartridge flares in foreground, with flash bombs at extremities of the "V". Abrams Instrument Corporation intervalometers, counters and count limiters are used for time control and recording.

DESIGNERS AND MANUFACTURERS

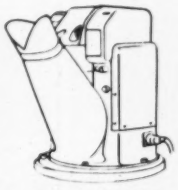


INTERVALOMETERS

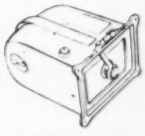
COUNT LIMITERS

COUNTERS

B-8A INTERVALOMETER



RADAR CAMERAS



SPECIAL CAMERAS

PHOTOGRAMMETRIC EQUIPMENT

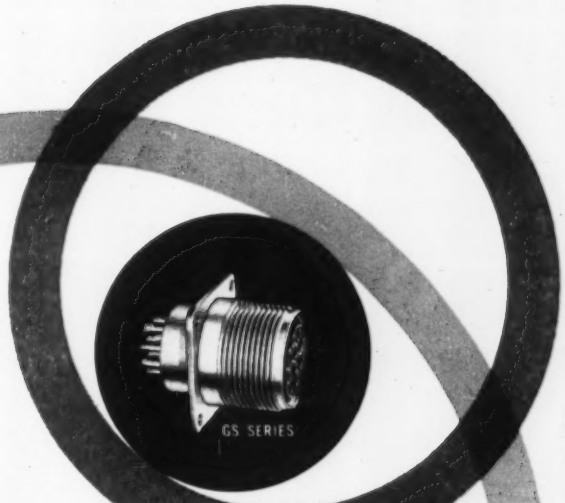
When supersonic aircraft were to be equipped for photo-mapping and camera shutter-flash syncronization, the problem of finding precise time control loomed large, — but Abrams was ready with the answer. For 15 years Abrams has been the principal source of supply of camera control instruments for the United States Armed Services. If you have a problem in special cameras or time control you too, can find an answer here.

ABRAMS INSTRUMENT CORP.

Designers and Manufacturers of Military and Industrial Cameras, Timers, Fire Control and Photogrammetric Equipment for a Third of a Century

606 E. Shiawassee St. ***Lansing, Michigan***

For more information circle **24** on inquiry card.



for **TRUE**

HERMETIC

SEALING

connect with cannon!

Hermetically-sealed multi-contact connectors made by Cannon are really rugged! And . . . they are the only connectors that give you **true hermetic sealing under such adverse pressure and atmospheric changes.** Here's why . . .

Cannon pioneered the first successful hermetically-sealed connector more than six years ago . . . since then has continuously refined and increased the line. All have special steel contacts. Vitreous insulation . . . **fused to both contacts and shell for a perfect permanent seal** . . . is stronger than steel, withstands temperatures to 600° F, and permits the use of the **highest conductive steel** contacts compatible with any vitreous fusing operation.

Available in a wide variety of insert layouts for control, relay, power, and instrument applications in Series GS, (AN type), KH, RKH, U, DAH, BFPH, TBFH, DBH, DCH, KOH, standard, miniature and sub-miniature sizes. Also, special mounting flanges and brazing service to help you obtain a strong and leakproof overall assembly.

CANNON PLUGS

DH SERIES

U SERIES

KH SERIES

Please refer to Dept. 180

CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California

Factories in Los Angeles; East Haven; Toronto, Canada; London, England.
Representatives and distributors in all principal cities are at your service.

first in connectors

For more information circle **25** on inquiry card.

Dependable
P.R. MALLORY & CO. Inc.
MALLORY
Mercury Batteries

Power Specialized Electronic Instruments

Mallory Mercury Batteries are used to supply power for transmitting data from balloon-borne equipment 20 icy miles in the stratosphere, and to record what goes on at the tip of a drill two superheated miles down an oil well. And they do their job dependably . . . where other types of batteries have failed.

Even under the most severe climatic conditions, Mallory Mercury Batteries give long, stable life and excellent operating characteristics. Particularly advantageous in instrument applications is the way they resist deterioration during extended storage periods. In addition, Mallory Mercury Batteries offer these features:

- **High ratio of energy to volume and weight**
- **Constant voltage and current—ideal for transistor circuits**
- **No need for recuperation periods**
- **Leak-proof, dimensionally stable construction**
- **Operation over wide temperature and pressure ranges**
- **Resistance to humidity and corrosive conditions**
- **Highly resistant to impact and acceleration**

Our new Technical Bulletin 1-8 gives complete data on single cells and multi-cell stacks and packs. Write for your copy today.

P.R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO. Inc., BATTERY DIV., NORTH TARRYTOWN, N.Y.

For more information circle **26** on inquiry card.

Now

SINGLE SEAT VALVES FOR *Large Flow Rates* WITH ANNIN'S

BUNYAN SERIES

DOMOTOR VALVES

Body Sizes . . . 6″- 8″- 10″

Body Design . . . Globe, angle and 3-way. Tight shut-off, single-seat body. Standard, Cooling Fin or Doolseal bonnet.

Body Ratings . . . Standard ASA 300, 600, 900, 1500, and 2500 PSI.

Operators . . . Domotor, cylinder and handwheel. Domotor operators for all pressures and pressure drops. Piston sizes of 200 and 400 sq. in. for thrusts up to 40,000 lbs. Domotor or Cylinder strokes to 6″ as required.

You'll profit by learning more about the superior features and better performance of Annin Control Valves.

THE ANNIN COMPANY

Dept. I, 6570 East Telegraph Road, Los Angeles 22, Calif.

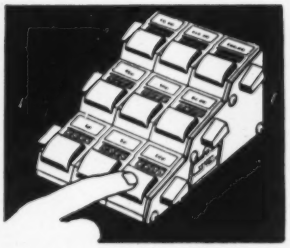
ANNIN *Control* VALVES

For more information circle **27** on inquiry card.

Added Evidence that . . .

Everyone Can Count on VEEDER-ROOT

In figuring out new systems of automatic electrical control, Veeder-Root *Count*rol can supply vital connecting links. For instance, this Predetermining Counter can be hooked into such a system to light a light, ring a bell, or actuate a mechanism to stop a machine or process *at any pre-set point.* And there are many other Veeder-Root Counters that can serve as "countponents" in almost any way desired. Or special counters can be designed for specific applications. Engineers in any industry, now engaged in working out automatic control systems, can count on Veeder-Root engineers to work with them on any problem where reliable facts-in-figures are needed.



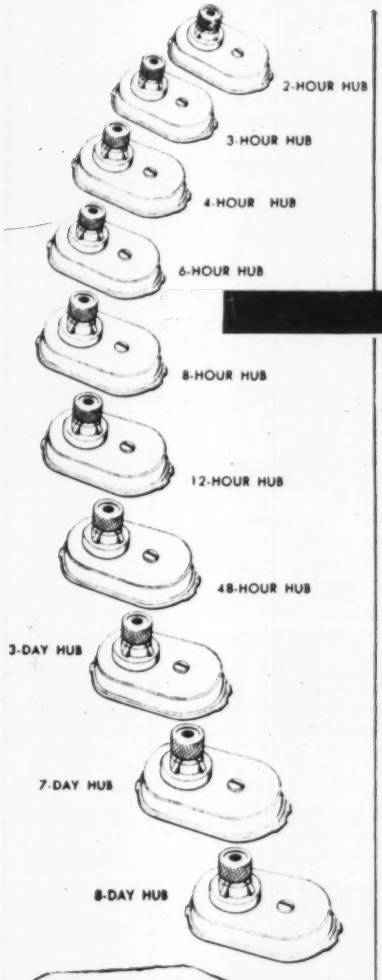
New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide. Write for news sheet and prices.

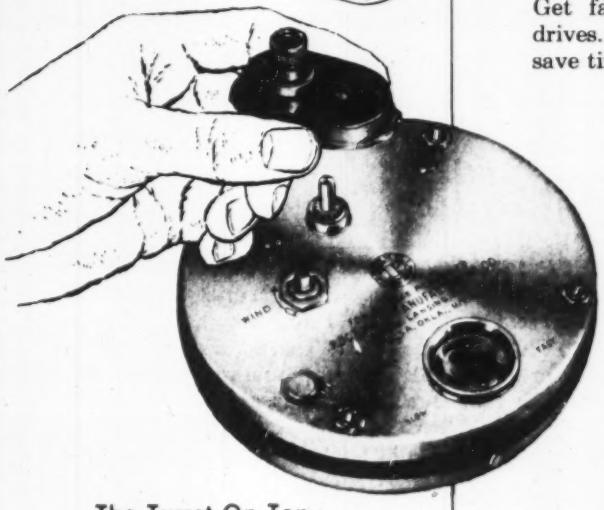
VEEDER-ROOT INCORPORATED • Hartford 2, Connecticut

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada
Dundee, Scotland • Offices and Agents in Principal Cities

"The Name That Counts"

For more information circle **28** on inquiry card.





The Turret On Top Does The Trick

Illustrating how the speed changing turrets are applied to the chart arbor to provide a wide selection of rotation rates.

Is Your Chart Drive Inventory Ready for Cold Weather?

JUST STOCK BASIC

ROCKWELL CHART DRIVES

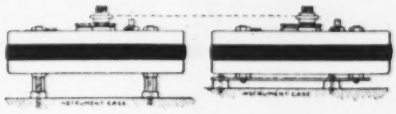
plus a selection of inexpensive

SPEED CHANGING TURRETS

FOR REPLACEMENT SERVICE, the Rockwell chart drive is the most versatile, economical you can use. Design dimensions were deliberately established so that the drive can be adapted to fit practically all instruments. One adaptor is furnished with each drive. There is no problem with rotation rates either. Speed changing turrets lock onto the chart arbor of the Rockwell drive to provide any one of 11 rotation cycles. Think what these features mean to you in reduced chart drive inventory, servicing and all-around flexibility of application.

Get facts now on versatile, long-lived Rockwell chart drives. Learn how their use in your instrument shop will save time and money. Write for bulletin 1079.

ADAPTORS TO FIT PRACTICALLY ANY INSTRUMENT



Illustrations show how adaptors are used to correctly locate Rockwell chart drives within instrument cases both as to position and height.

YOU CAN RELY ON ROCKWELL

ROCKWELL MANUFACTURING COMPANY

INSTRUMENT DIVISION • BOX 2396, TULSA, OKLA.

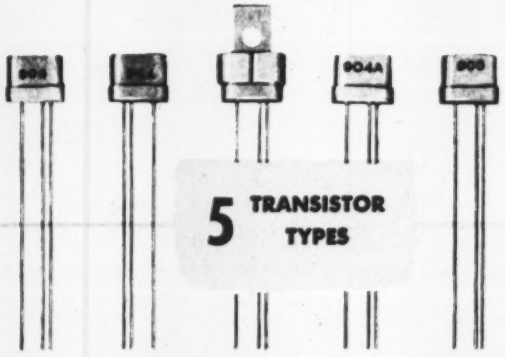
Atlanta • Boston • Charlotte • Chicago • Dallas • Houston
Los Angeles • N. Kansas City, Mo. • New York • Philadelphia • Pittsburgh
San Francisco • Seattle • Tulsa

For more information circle **29** on inquiry card.

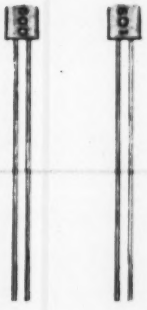
silicon

semiconductor devices available now in production quantities

HIGH VOLUME PRODUCTION of *silicon* semiconductor devices enables Texas Instruments to offer you an enlarged line of five types of silicon transistors and two types of silicon junction diodes . . . all available for immediate delivery in production quantities!



SILICON TRANSISTORS-produced commercially by and available *only* from Texas Instruments – are now available with alpha (current amplification factor) to over 0.975 and with alpha cutoff frequency to over 8 megacycles . . . stable to 150° Centigrade (302° F)!



SILICON JUNCTION DIODES are also manufactured by Texas Instruments from grown single crystals and feature back currents as low as 0.001 microamp and safe operation to 150° Centigrade! All TI semiconductor devices – *silicon* or germanium; diodes, triodes and tetrodes – are made with glass-to-metal hermetic seals.

WRITE FOR LITERATURE on semiconductor devices in the widest range available today!

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **30** on inquiry card.

FOR MAXIMUM
ACCURACY AND
DEPENDABILITY IN

AUTOMATIC TIMING

space-saving

synchronous

self-starting

self-lubricated

SYNCHRON®

TIMING MOTORS

Mounted in any position, SYNCHRON Motors will operate with equal accuracy and efficiency at any temperature from —40° to +140° F. They are available in standard speeds from 1 to 600 RPM, clockwise or counter-clockwise, all voltages and cycles.

Guaranteed to pull 8 in. oz. direct load continuously at 1 RPM. May be stalled indefinitely without injury to coil.

Gear reduction units available to convert any speed. Wide range of shaft styles and lengths or driving pinions. Special drives engineered to your specifications.

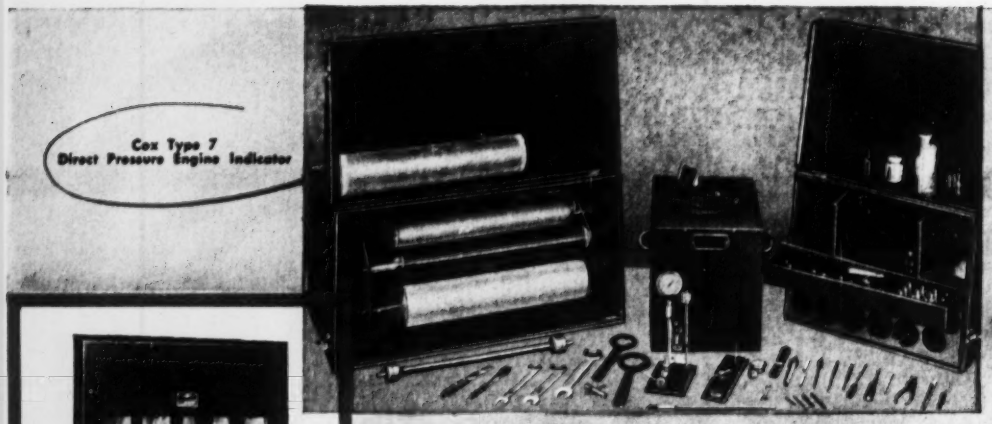
INVITATION TO DESIGNERS

If you have a device which requires special action or a fresh engineering approach, contact SYNCHRON engineers for design assistance. We shall be glad to cooperate in creating a movement to suit your requirements.

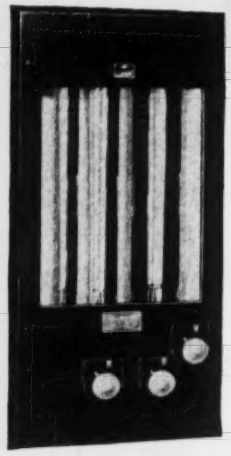
HANSEN MANUFACTURING CO., INC.

PRINCETON 9, INDIANA

For more information circle **31** on inquiry card.

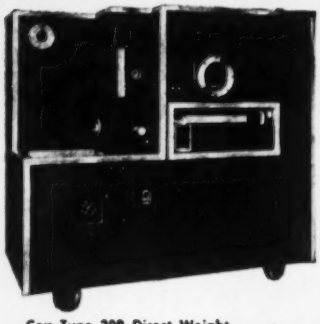


Cox Type 7
Direct Pressure Engine Indicator



Cox Type 12
Multiple Stage Flow-Meter

GOOD INSTRUMENTS ARE ALWAYS GOOD INVESTMENTS



Cox Type 309 Direct Weight
Method Flow-Meter Calibrating Stand

. . . and Making GOOD INSTRUMENTS

Has Been Our Business For Over 40 Years

WHAT ARE *Your* TESTING PROBLEMS?

If your particular testing problem involves flow rate measurement or some similar phase of hydraulics requiring special equipment, we invite you to submit your problem to us for research and study. A description of the process involved and all pertinent specifications should be included. If in the opinion of our hydraulics engineers the basic idea is practical, we will undertake design and development of the special equipment.

DESIGNING and building Cox Precision instruments has been the full time job of Commercial Research Laboratories, Inc. for over *40 years.*

The experience and specialized "know-how" we have gained is evident in the great number of Cox instruments currently being used by the automotive and aircraft industries, and by the U.S. Airforce, Army, and Navy.

Today, as in the past, scientists and craftsmen here at Commercial Research Laboratories are hard at work developing new and improved Flow-Meters, Flow-Meter Calibrating Stands, Fuel Nozzle test stands, and other Cox precision testing devices to help you in meeting tomorrow's testing problems. At the same time, we stand ready to help in designing and building the accurate precision instruments your *immediate* testing problems require — whether for the research laboratory or the production line.

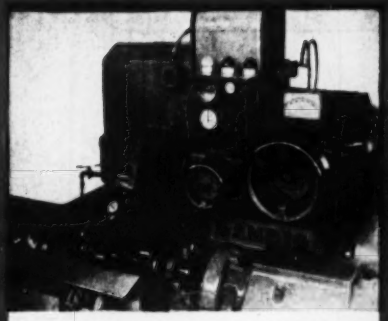
An example of modern CRL service is a flowmeter service department which we have just created. Using Cox Calibrating Stands, we are able to test any make or capacity flowmeter to determine to what *exact* percentage the instrument is accurate. In cases where design of the instrument will not allow re-calibration, correction curves can be supplied to guide users in future operation of the instrument.

Commercial Research Laboratories, Inc.

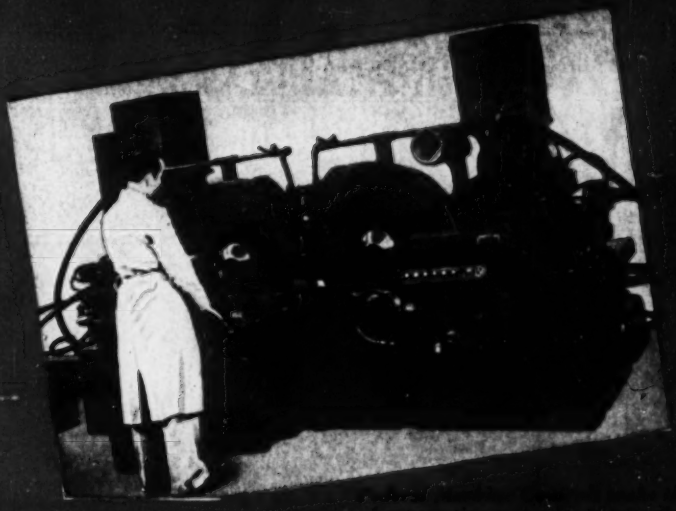
20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

MAKERS OF COX REGISTERED TRADE MARK **SINCE 1912: SINGLE AND MULTIPLE STAGE FLOWMETERS • FLOWMETER CALIBRATING STANDS • CARBURETOR FLOW STANDS • FUEL NOZZLE TEST STANDS • ENGINE INDICATORS • MAGNETIC THICKNESS GAGES • VIBRATION RECORDING EQUIPMENT BALANCED ELECTRONIC EQUIPMENT FOR PRESSURE AND VIBRATIONS.**

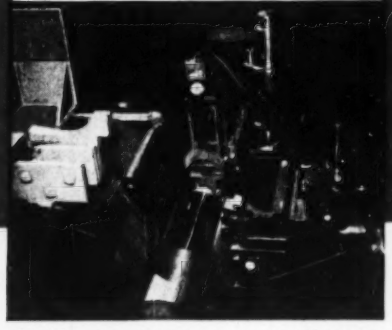
For more information circle **32** on inquiry card.



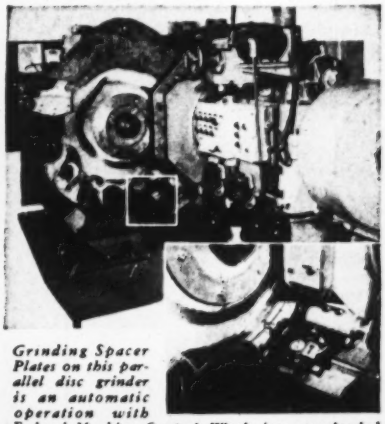
Grinding Main Journals on a Crankshaft is done quickly and without scrap with this Federal Air-Electric Grinding Gage. The operator loads the machine, snaps the caliper on the work and starts the machine cycle. When the work is down to size, the wheel automatically backs up. The large Air Dial and the three signal lights provide visual checks on the progress of the grinding. With this Machine Control Gage it is impossible to grind undersize scrap because the gage automatically backs the wheel up when work is to size.



FEDERAL *Automatic* MACHINE CONTROL GAGES



This Federal unit, employing an Arnold continuous caliper type grinding gage, automatically controls the size of the journal surfaces of 1100 lb. freight car axles. The gage, ordinarily retracted to provide loading clearance, automatically springs onto the work and takes control of the grinding process at the start of the grinding cycle. Signal lights tell the operator when work is "over size", "near size", or "to size" and are connected electronically to the machine controls so the grinding cycle is automatically stopped when the required size is obtained. Tolerances are consistently maintained well within the plus 0.0005", minus 0.0000" specified.



Grinding Spacer Plates on this parallel disc grinder is an automatic operation with Federal Machine Control. Workpieces are loaded in the slotted carrier wheel and the gage controls the feed of the wheels to compensate for wheel wear. Corrections are made alternately to each wheel-head to maintain the centering of the carrier wheel. Automatic controls assure continuous production of good pieces, eliminating scrap.

have established their efficiency

See us at Booth 719 at the FIRST INTERNATIONAL AUTOMATION EXPOSITION Nov. 29—Dec. 2, 1954 at the 244th Regiment Armory, N.Y.C.

AUTOMATION is a new term applied to an idea that general machinery manufacturers have been doing ever since Eli Whitney invented his Cotton Gin. But, controlling Machine Tools automatically so that they produce work to required sizes is comparatively new.

Federal, however, has been designing and building Gages for this purpose for several years. We offer this tried and proven experience to all builders and users of machinery where Automatic Dimensional Control of Machine Tools is desired. We can handle all phases of the work; from work-handling through gaging, machine control and disposal.

Federal is ready to provide standardized package units for air, electrical, electronic or combination controls and **will cooperate with your engineers to adapt these to your machine requirements.** Call —

FEDERAL PRODUCTS CORPORATION
44111 EDDY STREET • PROVIDENCE 1, RHODE ISLAND

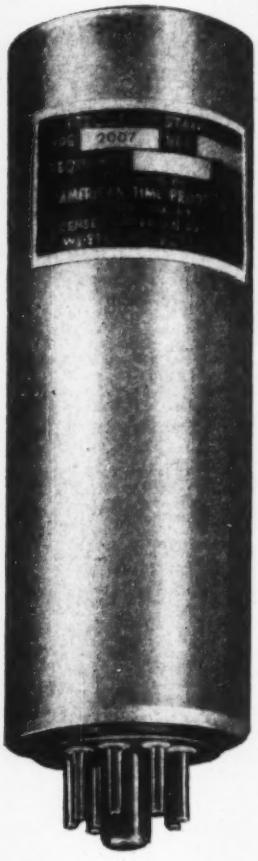
SOME OF MANY POSSIBILITIES

- Percentage reject control. A simulation of automatic statistical Q.C.
- Automatic shut-off when dimension out-of-control.
- Automatic tool adjustment or compensation.
- Tool Adjustment Signalling.
- Automatic classification according to dimension.
- Automatic line operation signals, etc., etc.

Ask **FEDERAL**
FOR ANYTHING IN MODERN GAGES...

REALLY *New!*

COMPLETE *miniature* FREQUENCY STANDARD



ACTUAL SIZE

A compact, complete, hermetically sealed frequency standard, presenting these features:—

1. JAN-ized construction throughout.
2. SPACE-SAVING, 1½" dia. x 4½" high.
3. WEIGHT, approximately 10 ounces.
4. AVAILABLE in 400 and 500 cycles.
5. ACCURACY—.002% (15° to 35°C).
6. SHOCK-MOUNTED on Silicone rubber.
7. POWER REQUIRED, 6 V. at 300 ma. 70 to 200 V. at 1 to 5 ma.

WRITE FOR DESCRIPTIVE LITERATURE, SPECIFYING "TYPE 2007"

Also, manufacturers of frequency standards, multi-frequency standards, chart-recording chronographs, firing-cycle timers, the Watch-Master Watch Rate Recorder and other high-precision frequency and timing instruments, controlled by our tuning-fork oscillators.

Engineers!

Gear this frequency standard to your designs and help solve climatic, space and weight problems in JAN-ized-MIL equipment

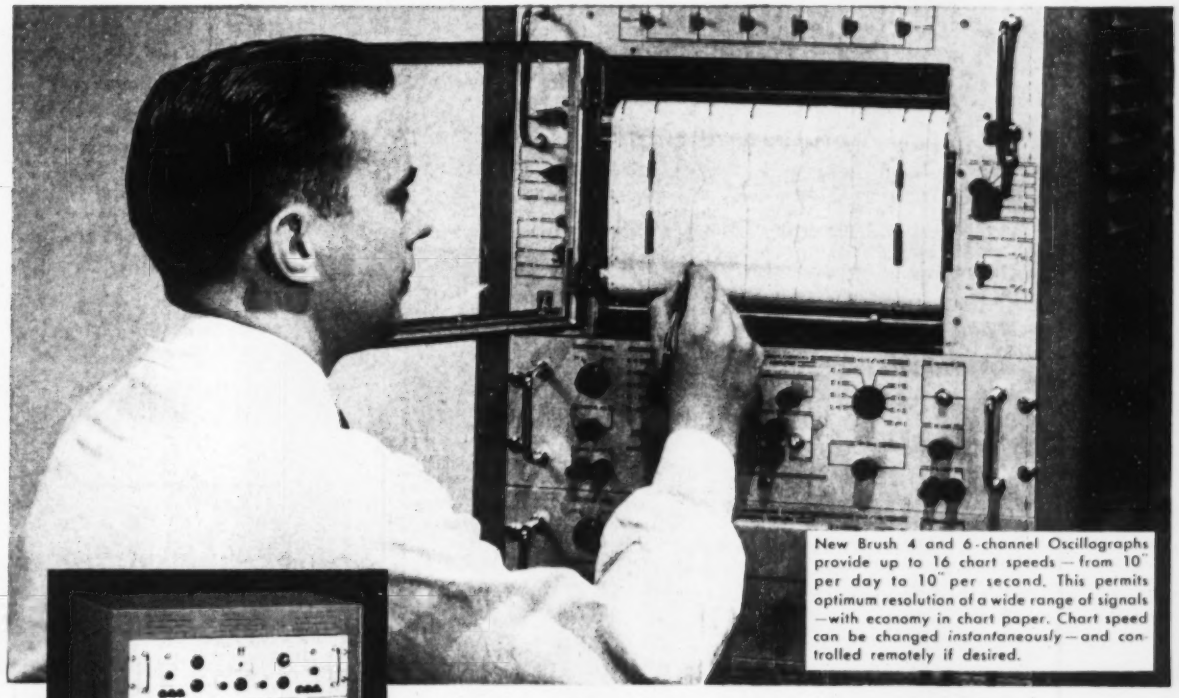
American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

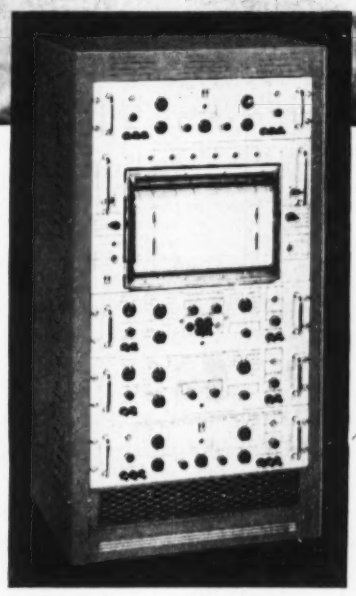
MANUFACTURING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

For more information circle **34** on inquiry card.

FULL RANGE INSTRUMENTATION!

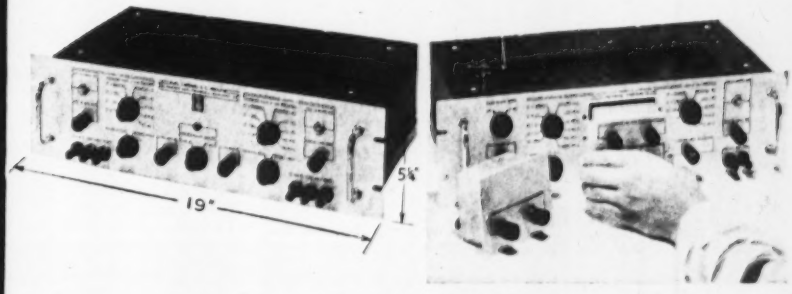


New Brush 4 and 6-channel Oscillographs provide up to 16 chart speeds — from 10" per day to 10" per second. This permits optimum resolution of a wide range of signals — with economy in chart paper. Chart speed can be changed *instantaneously* — and controlled remotely if desired.



New Brush Recording Systems are designed to meet many mounting requirements — standard 19-inch racks, bench-top, or floor consoles. New Brush Amplifiers are lighter, smaller and can be stacked closely as shown.

NEW BRUSH RECORDING SYSTEMS *offer you greatest flexibility in measurements*



Above: New Brush dual-channel D. C. Amplifier Model BL-530 accepts either single ended or balanced signals, provides a 50 millivolt sensitivity and accurate calibration of the signal to be recorded.

Right: New Brush Universal* Amplifier Model BL-520, when used with the appropriate resistive or inductive transducer, permits measurement and direct recording of physical phenomena: strain, torque, force acceleration, velocity, displacement, pressure, temperature, etc. Maximum sensitivity is equivalent to ½ microvolt per chart millimeter; or in strain measurements — .25 microinch per inch. The Amplifier includes a medium gain direct-coupled amplifier section with calibrated attenuator that may be used separately for voltage and current measurements.

*Trade Mark

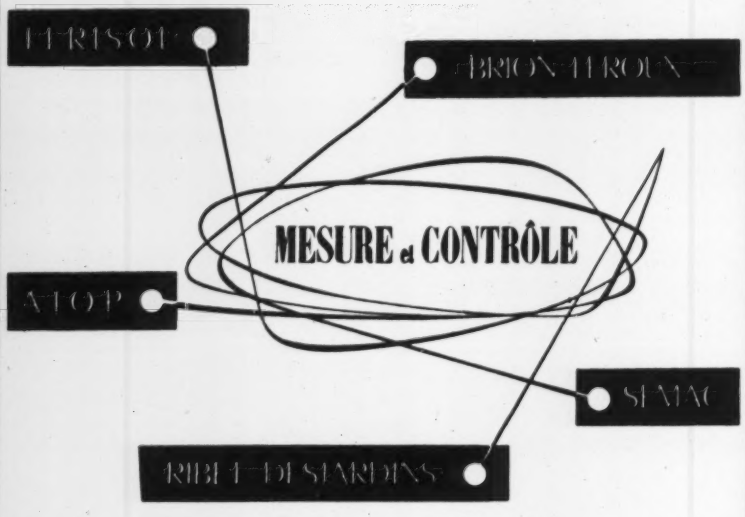
Brush Recording Systems have an important place in your research and production instrumentation. Write today or call your nearby representative for complete information. Brush Electronics Co., Dept. A-11, 3405 Perkins Ave., Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

For more information circle **35** on inquiry card.



from France

Electric Measuring and Automatic Control Instruments

• automatic strain-gage measuring devices • galvanometers, voltage stabilizers • signal generators, electronic volt- and millivoltmeters • magnetic comparators, electronic commutators, CRO's • gas analyzers, pressure regulators, flow- and pH meters.

These and other devices for measurement and automatic control are available through

MESURE et CONTROLE

Foreign trade office for: Association des Ouvriers en Instruments de Precision, Brion-Leroux, Ferisol, E. Geffroy & Cie, Ribet-Desjardins, Societe d'Etude de Materiel Automatique et de Controle

For literature and further information, write to

MESURE et CONTROLE 40 quai de Jemmapes PARIS 10, France

For more information circle **36** on inquiry card.

SCIENTIFIC AND INDUSTRIAL GLASS BLOWING AND LABORATORY TECHNIQUE

By WILLIAM E. BARR and VICTOR J. ANHORN

$6.00 postpaid

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $..... for ..... copies of GLASS BLOWING at $6.00 each.

Name .....

Address .....

City .....

Maintenance and Servicing of Electrical Instruments

By JAMES SPENCER

In charge of Instrument and Relay Dept., Meter Div., Westinghouse Electric Company.

$3.00 postpaid

(Payment must accompany order)

Instruments Publishing Company
845 Ridge Avenue,
Pittsburgh 12, Pennsylvania

Enclosed is $..... for ..... copies of Spencer's Maintenance & Servicing of Electrical Instruments at $3.00 each, postpaid.

Name .....

Address .....

City .....

Announcing—the first and much-needed book on small research reactors

Nuclear Reactors for Industry and Universities

written by eight eminent authorities and edited by Ernest H. Wakefield

CONTENTS

Chapter I. Nuclear Reactor Types
Chapter II. Availability and Selection
Chapter III. Radioactivity Measurement
Chapter IV. Radiation Protection
Chapter V. Reactor Control
Chapter VI. Instruments for Experiments
Chapter VII. Cost Study
Chapter VIII. Legal Aspects

APPENDIX—Glossary of Terminology, Cloth, 102 pages, photos and diagrams, 4-page index.

$2.00 postpaid

Remittance must accompany order

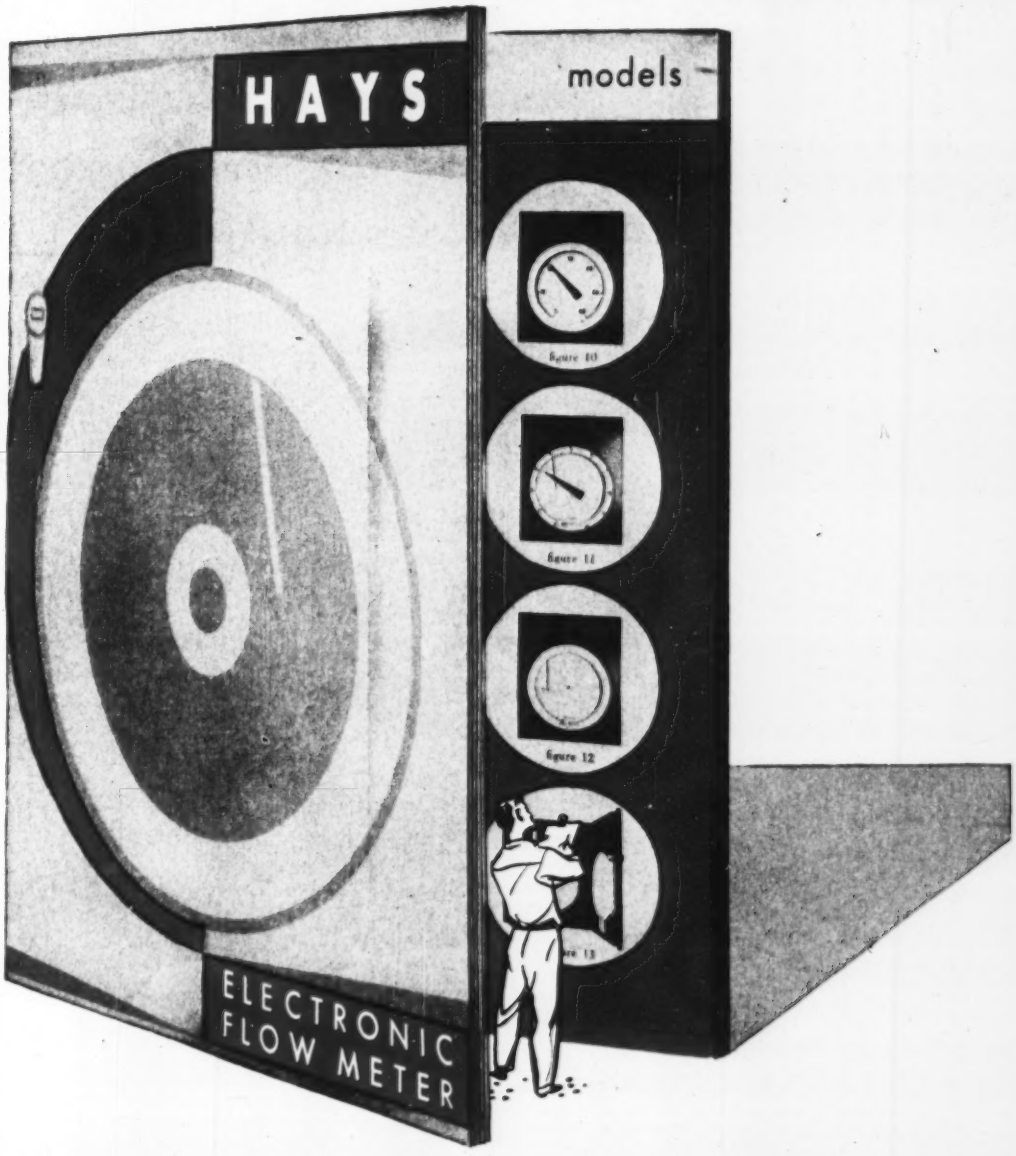
Instruments Publishing Company
845 Ridge Avenue,
Pittsburgh 12, Pennsylvania

Enclosed is ..... for ..... copies of Wakefield's Nuclear Reactors book at $2.00 each, postpaid.

Name .....

Address .....

City .....



A guide to better flow metering

Here's a new fact-filled, technical booklet that tells you feature for feature how the new Hays electronic flow meter excels.

Electronic operation—provides maximum accuracy (¼% of full scale differential), and speed (4 seconds for full scale pen travel).

Mercuryless transmitters—rupture-proof metallic bellows for differential pressure measurement.

Continuous integration—motor-driven, continuous mechanical integrator is extremely accurate even on rapid load changes.

Other features include powerful motor, easy readability, accuracy unaffected by normal temperature changes, optional explosion and weather-proof transmitter.

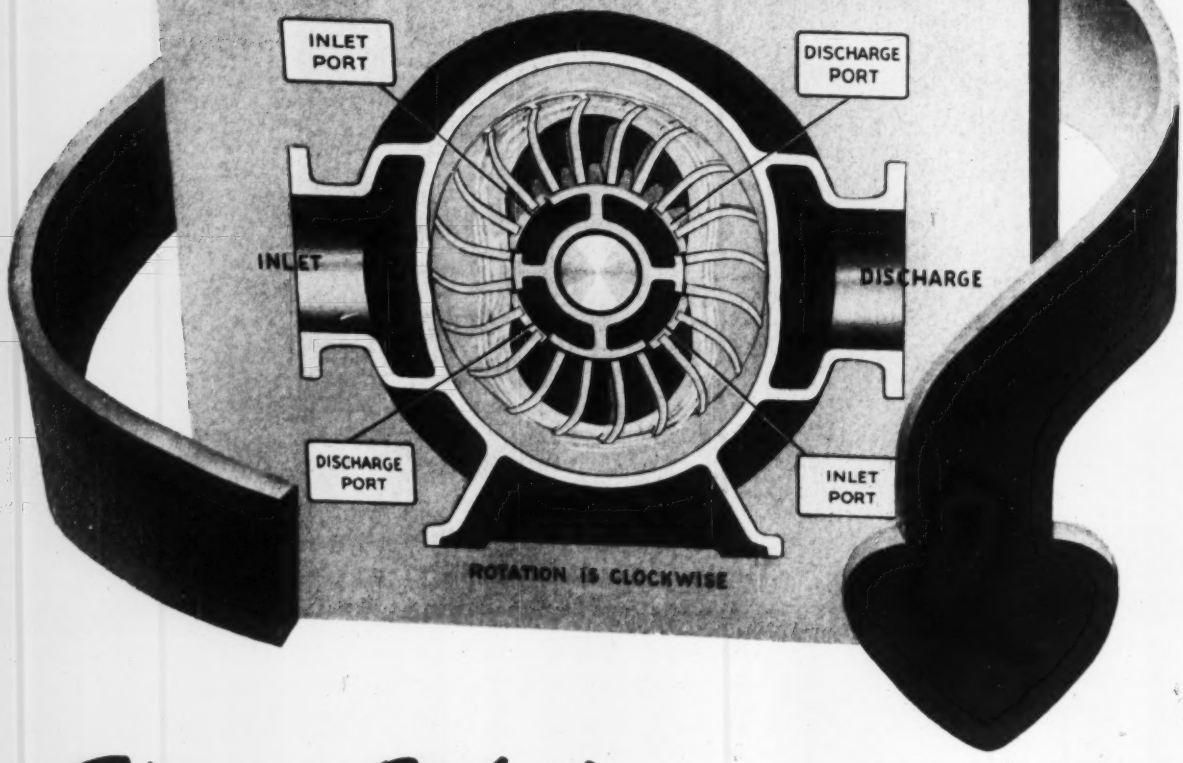
Write for bulletin 54-1074-222 and get the important facts.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Variflow Meters and Varitrol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION
MICHIGAN CITY, INDIANA

For more information circle 37 on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



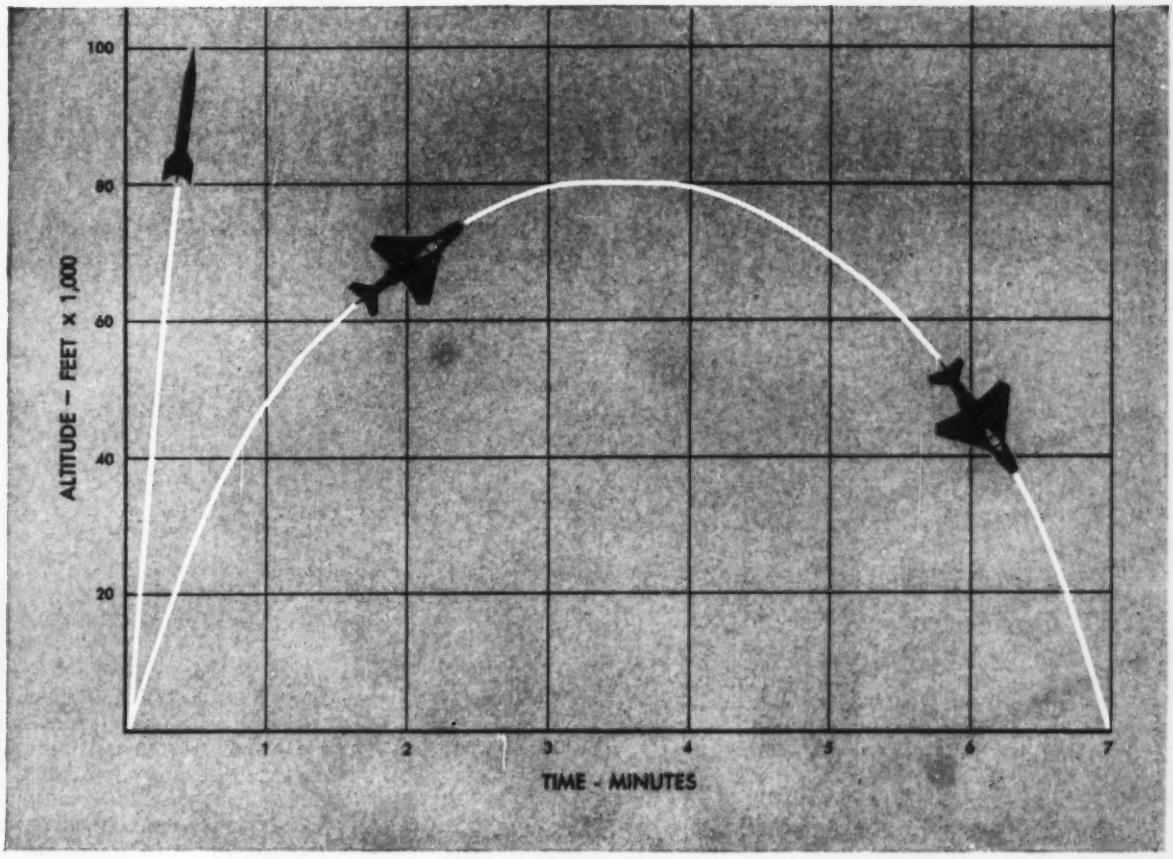
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



Sea Level to 80,000 Feet *in Three Minutes*

One of the many successful applications of Hagan Automatic Control is simulating flight conditions for testing jet engine components.

The automatic control system changes test chamber pressure (on a programmed basis), from sea level to 80,000 feet in three minutes. The program can be stopped at any altitude setting, for automatic control of a steady test chamber pressure.

For this installation, a programmed pneumatic signal dictates test chamber pressure to a regulator for conversion into a controlling signal to a hydraulic pilot valve. This, in turn, directs high pressure oil to a linear travel power unit for extremely fast and accurate operation of the controlling damper.

This Is Important

The same Hagan Automatic Control System is ready now for simulating flight to 80,000 feet in six seconds.

With the equivalent system utilizing Hagan electronic control elements, programmed trajectories from sea level to 100,000 feet in three seconds are obtainable.

HAGAN
HALL
BUROMIN
CALGON

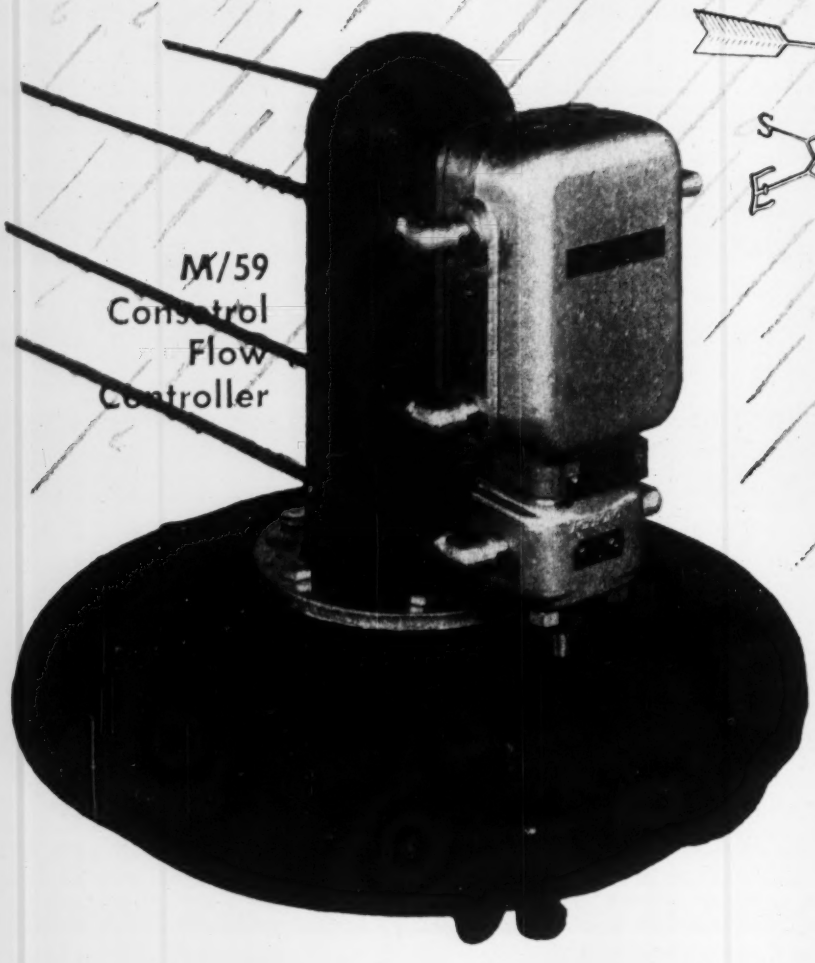
Hagan Corporation
AERONAUTICAL AND SPECIAL PRODUCTS DIVISION
HAGAN BUILDING, PITTSBURGH 30, PA.

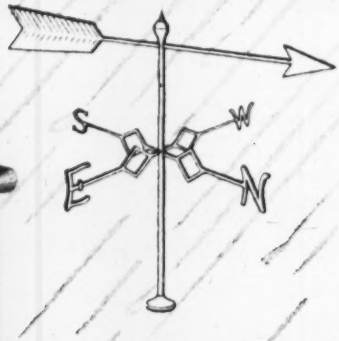
Control Systems for Automotive andAeronautical Testing Facilities
Ring Balance Flow and Pressure Instruments
Metallurgical Furnace Control Systems
Boiler Combustion Control Systems

For more information circle **38** on inquiry card.

This Controller

requires no more attention than a weathervane!





Like a weathervane, the Foxboro M/59 Consotrol Controller can be installed completely exposed to the elements . . . and forgotten about! Unsurpassed in performance by any other flow controller, the M/59 is *completely indifferent to weather conditions.*

This rugged Flow Controller mounts directly on the air connection of the valve . . . at a fraction of usual installation cost. Its case is tightly gasketed, continuously purged, completely weatherproof, highly resistant to dust, fumes, and vibration. There's nothing to align, nothing to wear out. A flexure-strip fulcrum eliminates the friction and wear of conventional pivots . . . eliminates "conventional" maintenance.

In operation, the M/59 fully utilizes the speed and sensitivity of the Foxboro d/p Cell Flow Transmitter . . . does away with transmission lag . . . gives fastest recovery from process upsets. For the *complete* story, write today for Bulletin 470.

"Live-Balance" Control on any fluid with any size valve motor.

Lowest first cost. Lowest installed cost.

Lowest maintenance cost.

Unique Simplicity — exclusive design permits fixed, optimum proportioning and reset values for liquid flows. Adjustable reset optional for gas or steam flow.

THE FOXBORO COMPANY, 4611 NEPONSET AVENUE, FOXBORO, MASS., U.S.A.

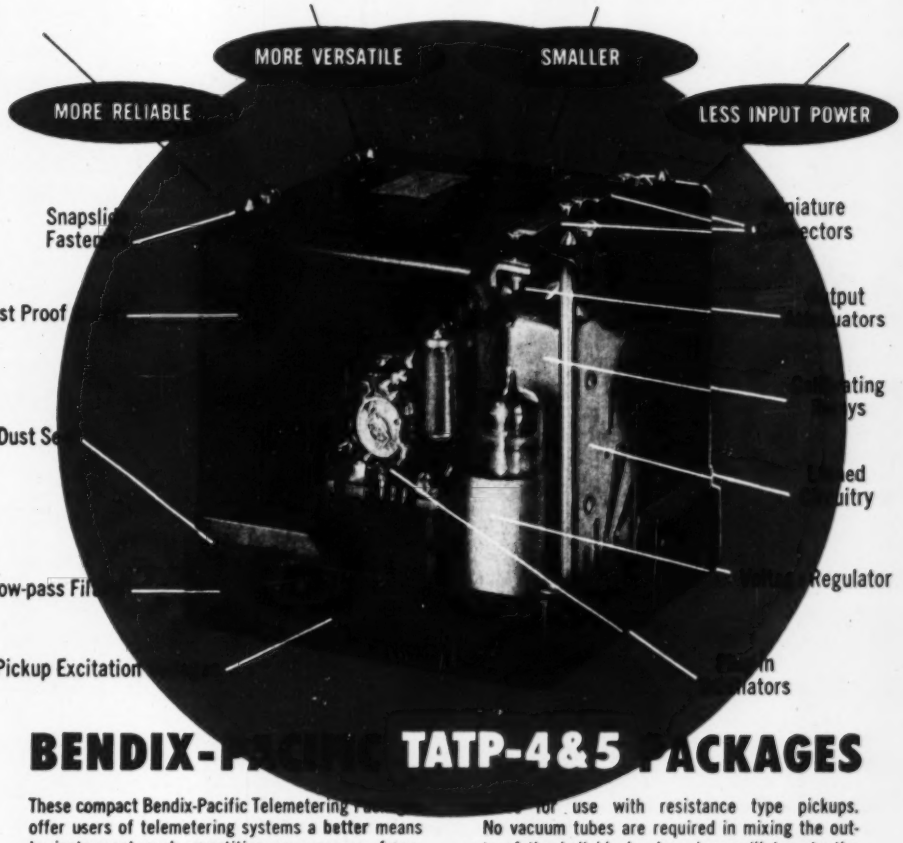
FOXBORO
REG. U. S. PAT. OFF.

FLUID FLOW CONTROLLERS

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

For more information circle **39** on inquiry card.

A NEW TELEMETER STANDARD



BENDIX-PACIFIC TATP-4&5 PACKAGES

These compact Bendix-Pacific Telemetering [illegible] offer users of telemetering systems a **better** means to instrument such quantities as pressure, force, temperature, voltage, acceleration and vibration.

The units are smaller and various combinations may be used to provide compact multi-channel systems of up to 18 subcarrier bands. Each unit operates on **unregulated** +150 VDC and 28 VDC since it contains its own voltage regulating circuits. Each unit may be provided with individual relays for switching oscillator inputs from signal to calibrate position. Model TATP-4 contains four and Model TATP-5 contains six separate and independent regulated +5 VDC excitation voltage [illegible] for use with resistance type pickups. No vacuum tubes are required in mixing the outputs of the individual subcarrier oscillators to the composite audio signal for direct modulation of the RF transmitter, thus greatly improving the reliability of the system at a point where a tube failure would affect **all** subcarrier channels.

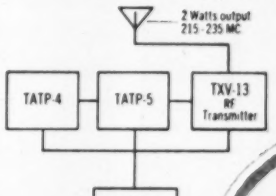
Standard Bendix Model TPP-6 Power Supplies are available to handle from one to three of these telemeter packages plus a 2 watt crystal controlled RF transmitter. Many types of interchangeable subcarrier oscillators are also available. RF amplifiers are available for increased power outputs up to 100 watts.

CHARACTERISTICS

	TATP-4	TATP-5
No. of bands	4	6
Subcarrier bands	1.7 kc. to 70 kc.	1.7 kc. to 70.0 kc.
Oscillator Types	TOE-30V, TOE-31V, TOR-8V, TOR-9V, TOL-9V	Same as TATP-4
Input Voltages	6, 12, or 24 VDC ±10% 150 VDC $\pm\frac{10}{5}$%	6, 12, or 24 VDC ±10% 150 VDC $\pm\frac{10}{5}$%
Weight (Less Oscillators)	Approx. 2 lbs.	Approx. 3 lbs.
Dimensions	5.0" x 5.0" x 4.5"	5.0" x 7.5" x 4.5"

Write for Complete Information

TYPICAL 10 BAND SYSTEM



PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

East Coast Office:	Export Division:	Canadian Distributors:	Dayton, Ohio	Washington, D.C.
475 5th Ave., N.Y. 17	Bendix International 205 E. 42nd St., N.Y. 17	Aviation Electric, Ltd., Montreal 9	1444 Cory Drive, Dayton 6, Ohio	Suite 803, 1701 "K" St., N.W.

For more information circle **40** on inquiry card.

RADAR

SONAR

HYDRAULICS

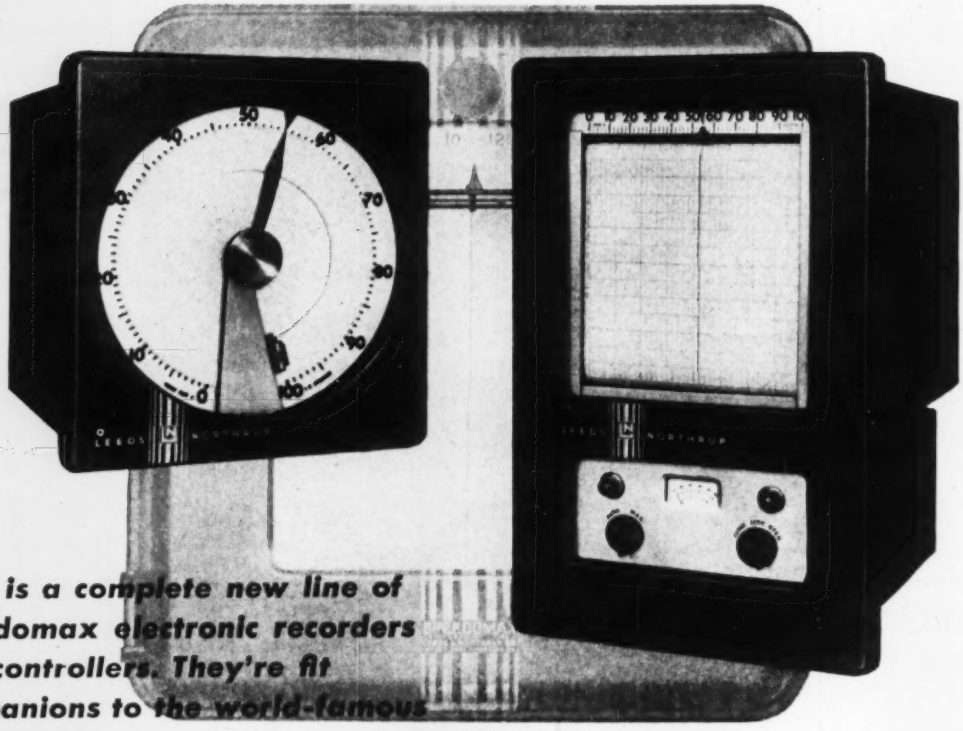
TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS

New, compact

Speedomax® Instruments can modernize process control in hundreds of plants!



Here is a complete new line of Speedomax electronic recorders and controllers. They're fit companions to the world-famous Speedomax Type G. They are called Type H.

These new instruments can help the operation of a tremendous variety of industrial processes—including many which are perhaps now under-instrumented. And L&N's new production techniques bring Speedomax H equipments within reach of processes which couldn't formerly justify high-quality electronic potentiometers.

Especially significant to operators who now employ filled-system and deflection instruments are the benefits of electronic potentiometer performance. For instance, you can install Speedomax wherever you wish, without a thought for the distance to its sensing element. And Speedomax won't "drift" in accuracy as it ages—it stays on the job and holds the process on spec. If you damage either the sensing element or lead, you simply repair or replace on the job. Speedomax never goes back to the factory for re-calibration, so you do not need spares—thus you save both inventory and storage space.

Anyone familiar with L&N construction will see it again in Type H. The same husky components, anti-friction bearings, rigid assembly and ultra-accessability.

New features include a "fill-in-place" pen; a new, ingenious on-off control switch; more plug-in components. External leads go to a terminal board on outside back of case, for easy installation and maintenance.

One of the round-chart instrument's special features is its long scale; this is used both in setting the control point and for reading temperature. All instruments have especially easy, accurate means for moving the control point setter.

You can choose any type of control action—On-off; Proportional Action; Proportional with rate and reset actions. Any L&N office can supply details and application engineering assistance; or write us at 4955 Stenton Ave., Philadelphia 44, Pa.

LEEDS LN **NORTHRUP**
instruments *automatic controls • furnaces*

For more information circle **41** on inquiry card.

Editorial...

Instruments and AUTOMATION

FIRST INTERNATIONAL AUTOMATION EXPOSITION —and COMPUTER CLINIC

ADVANCE registration for the First International Automation Exposition, to be held November 29 to Dec. 3, 244th Regiment Armory, 14th Street between 6th and 7th Aves., New York City, shows that top management from all parts of the United States is planning to attend. The widespread publicity on the subject of automation has aroused an intense interest in the field—and answers to many yet-unanswered questions will be sought at this important exposition.

The manager of the exposition—the world's recognized leader and promoter in the fields of measurement and control—has brought together the most advanced devices for control of plant and factory operations. Examination of the list of products to be exhibited (see following pages) reveals that all "frontiers" of modern instrumentation will be represented—computers, analog-to-digital converters, data monitoring, data scanning, digital data representation, analytical instruments, process instrumentation, and factory instrumentation. Thus, for the first time, all the individual elements of the now obtuse picture of the "automatic plant" and "automatic factory*" will be assembled and presented in a space small enough to permit perspective to be gained about the entire field—and yet large enough to contain all the important elements of the field.

OUTSTANDING in importance and significance will be the complete coverage of electronic computers—analog and digital, general-purpose and special-purpose. Never before has this new and dramatic field been presented with the express purpose of examining and comparing all of its aspects—including where each type can find economic and optimum use. This has been done in two ways:

1. Manufacturers of all basic types will have exhibits planned to answer specific questions of those attending the Exposition. The following manufacturers of computers will be represented:

Company	*Computer Type*
Austin	Special-purpose computers
Bendix Aviation	Digital differential analyzers
Electronic Associates	Analog computers, general purpose systems
Goodyear Aviation	Analog computers, general purpose systems
International Business Machines	Complete electronic computer systems
Remington Rand	Complete electronic computer systems

2. Clinic sessions (2-hour classes) will be offered by the above computer manufacturers to all registrants to a *Computer Clinic*, which will be held on November 30, December 1, and December 2—in the booths of the manufacturers. Representatives of large industrial and scientific organizations from all parts of the United States already have registered for this important Clinic, which represents a new concept in education technique associated with an industrial exposition. Foreign observers are watching this development with interest.

*The reader is referred to the series of articles "The Automatic Factory—a Critical Examination," now appearing serially in this magazine, for details on the elements of an automatic factory, the problems now existing, and the experiences of typical factories with automation programs.

FIRST INTERNATIONAL AUTOMATION EXPOSITION

EXHIBITORS and their PRODUCTS

NOVEMBER 29 to DECEMBER 2

244th Regiment Armory, New York City, N. Y.

Booth No.

Analytical Measurements, Inc., Chatham, N. J. 607
In attendance: Frank G. Paully, Pres.; Kurt J. Lesker, Jr., Sls. Engr.; Gregory Ruffa, Adv. Mgr.

Assembly Products, Inc., Chesterland, Ohio 317
Exhibiting: New Products—Versatrols, to automatically control processes or operations which can be converted to an electrical value; ruggedized and sealed meter-relays; VHS plug-in relays. **Regular Products**—Indicating and controlling pyrometers; panel meters; contact meter-relays.
In attendance: Bradley Thompson, President; John Saint-Amour, V. P. Engrg.; Bob Pugsley, Sales & Mfg.; Bob Jones, Mfg.; Paul Saint-Amour, Sales Engr.

Atomic Instrument Co., Cambridge 39, Mass. 204
Exhibiting: Electronic counting and control instruments.

Austin Co., Special Devices Div., New York 11, N. Y. 419
Exhibiting: New Products—System to record analog data in digital form for direct control of processes. Shaft Position Quantizer, an analog to digital converter directly coupled to data shaft. Digital integrator for complex functions. **Regular Products**—"Computrol", computers that control.
In attendance: C. L. Foster, Div. Mgr.; A. H. Kuhnel, Div. Engr.; R. E. Schram, W. L. Hansen, Sales Engrs.; C. D. Cole, W. G. Birkel, Project Engrs.; J. R. Poole, Asst. Div. Engr.

Baldwin-Lima-Hamilton, Philadelphia 42, Pa. 721, 723
Exhibiting: SR-4 load and pressure cells, torquemeter, strain gages, dial indicator.
In attendance: A. R. Kilgore, Sls. Prom. Mgr.; H. A. Nielsen, A. N. Shore, J. K. Strickland, Sales Engineers; F. G. Tatnall, Mgr. of Research; M. L. Hall, Prod. Mgr.

Balteau Electric Corp., Stamford, Conn. 615
Exhibiting: New Products—Industrial X-ray unit for stationary or mobile inspection within the plant.
In attendance: Fred C. Sarchet, Sls. Engr.

Bendix Computer Div. of Bendix Aviation Corp. Los Angeles 45, Calif. 401
Exhibiting: Display, centered around the application of computers to control problems, will show bits and pieces of computers and descriptive literature on computers.
In attendance: Richard F. Walz, Sales Mgr.; C. B. Dennis, Sales Engr.; L. S. Michels, Mathematician.

Beta Electric Corp., New York 29, N. Y. 415
Exhibiting: See listing for RMC Associates.

Brush Electronics Co., Cleveland, Ohio 404
Exhibiting: See listing for Burlingame Associates, Ltd.

Burlingame Associates, Ltd., New York 13, N. Y. 404, 406
Exhibiting: Working display of electronic instrumentation featuring products of Brush Electronics (multichannel oscillographs, universal amplifier, dual-channel d-c. amplifier, digital counting devices); Donner Scientific (laboratory oscillator, wave analyzer, analog computer, comparator bridge, video probe amplifier); Electro-Pulse (pulse generators, oscillator); Electronic Measurements (super-regulated power supplies); Hycor Sales (resistors, attenuators, toroid coils, filters); Laboratory for Electronics (oscilloscope, time-rate indicator, oscillator, delay trigger generator, spectrometer, decade counters, delay lines); Labscope (equal amplifier d-c. oscilloscope); Magnetic Research (magnetic amplifier regulated supplies, magnetic amplifiers, and low-level signal convertors).
In attendance: Field Engineers Al Craig, Bob Crane, Jon Takakjian, Martin Maloy, Gerard Sullivan, Ken Grayson, Roland Reisley, Harold Hogin.

Crawford Fitting Co., Cleveland 10, Ohio 302
Exhibiting: Tube fittings, connectors.

Doelcam Corp., Boston 35, Mass. 601
Exhibiting: New Products—Microceiver, a magnetic voltage-regulated power supply, demodulator, and indicator for remote measurement of variables; magnetic d-c. null indicator; magnetic servo amplifier. **Regular Products**—Amplifiers, synchros, servomotors, gyroscopes, microsyns, pickoff, aircraft flight test equipment.
In attendance: N. E. Andres, Jr., Adv. Mgr., E. C. Carlson, Mid-West Regional Mgr., J. E. Egbert, Sls. Mgr., D. S. Marr, South-East Regional Mgr., J. A. Vitka, Sls. Coordinator.

Donner Scientific Co., Berkeley, Calif. 404
Exhibiting: See listing for Burlingame Associates, Ltd.

Dynamic Gear Co., Inc., Amityville, N. Y. 619
Mgr.; J. A. Vitka, Sls. Coordinator
Exhibiting: New Products—Precision stock gears in medium and fine pitches, primarily for instrumentation. **Regular Products**—custom gears fabricated from supplied specifications.
In attendance: William A. Wiegand, Pres.; Fred C. Johnson, Treas.; Edward L. Martin, Sec.; James Wheat, Russell A. Bird, Salesmen.

Electro-Pulse, Inc., Culver City, Calif. 404
Exhibiting: See listing for Burlingame Associates, Ltd.

Electronic Associates, Inc., Long Branch, N. J. 101
Exhibiting: New Products—Analog computer for solution of linear differential equations. Servo voltmeter, analog voltage indicating device. **Regular Products**—Computers, potentiometers, d-c. plotting equipment, d-a. converters, arbitrary function generators. **Services**—Analog computers facility on rental basis, Princeton, N. J.
In attendance: Charles J. Marsh, Jr., Dir. of Sls.; Stephen A. Voelker, Mgr. Engrg. Sls.; John D. Strong, Appl. Engr.; Davis H. Corkran, Eastern Sls. Engr.; Jerome D. Kennedy, Mid-western Sls. Engr.; Charles C Caparn, Field Engr.

Electronic Measurements Corp., Eatontown, N. J. 406
Exhibiting: See listing for Burlingame Associates, Ltd.

Falstrom Company, Passaic, N. J. 711
Exhibiting: Instrument and automation steel and aluminum instrument panels, cubicles, and cabinets.

Farrand Optical Co., Inc., New York 70, N. Y. 611
Exhibiting: New Products—Rotary and lineal "Inductosyna" multipole synchro elements which serve as shaft position data transmitter or receiver. **Regular Products**—Precision and distance measuring systems; automatic machine tool controls.
In attendance: J. Winget, Chf. Electronics Engr.; C. Urban, Proj. Engr.; E. B. Brown, Chf. Proj. Engr.; C. L. Farrand, Jr., Tech. Services Engr.; D. A. Korman, Sls. Mgr.

Federal Products Corp., Providence 1, R. I. 719
Exhibiting: Six demonstrating displays of dimensional machine control gages applied to center, centerless, parallel disk, and surface grinding machines. **Services**—Design, build, and service automatic dimensional machine control gages.
In attendance: Walter Warrel, Allen Souler, Sales Engineers; Al Sanford, Mgr. Automation.

Feedback Controls, Inc., Alexandria, Va. 218
Exhibiting: New Products—Packaged servo systems, for computer and control system fabrication. Standard sealed magnetic amplifiers. Plug-in booster amplifiers, a-c. operational amplifiers. **Regular Products**—Gear trains, heads; speed reducers, limit stops, slip clutches, single and multiple speed dials.
In attendance: Alexander Long, Pres.; W. Ronald Davies, V. P.; T. Greenburg, Rep.

Femco, Inc., Irwin, Pa. 701
Exhibiting: New Products—Bit Step Control and Bit-Step Carrier Control indication systems employing single pair of wires to bring back to central point or points information such as position of moving equipment and for remote control of equipment. **Regular Products**—Trolley-phone and other communication systems.
In attendance: J. M. Appel, Pres.; N. F. Agnew, V. P.; Ad. Davidson, Jr., Salesman.

General Precision Laboratory, Inc., Pleasantville, N. Y. 208
Exhibiting: New Products—Industrial TV system using lightweight camera and plug-in unitized control elements. **Regular Products**—Industrial TV, accessories, and components.
In attendance: Dr. R. L. Garman, V. P. and Managing Dir.; Blair Foulds, V. P.; E. A. Hungerford, Jr., Mgr. TV Dept.; N. M. Marshall, TV Sales Eastern District Mgr.; P. A. Lovelock; A. V. Anderson; S. L. Thomas; A. F. Brundage; G. Q. Herrick; E. H. Lombari; J. W. Belcher.

G. M. Giannini & Co., Inc., Pasadena 1, Calif. 709
Exhibiting: New Products—2000-count commutator for analog to digital conversions; indicating large-size "light-bank" for 20 or 30-ft. viewing of digital information. **Regular Products**—Angular position encoder for analog to digital conversions; system kit to translate potentiometer information into digital output.
In attendance: D. H. Putnam, V.P.; W. J. Beagan, J. P. Brogan, J. A. Gregorio, L. M. Ryan, J. T. Nelson, Sales Engrs.

Russell T. Gilman, Inc., Milwaukee 11, Wis. 205
Exhibiting: New Products—Standard slides and spindles for special machine construction. **Regular Products**—Cam-operated power units; indexing machines. **Services**—Adapting standard units for automation.
In attendance: Richard A. Buttke, Chf. Engr.; Les G. Ireland, Sls.; George W. Gilman, Plant Mgr.; A. H. Nisiewicz, Engrg.; Russell T. Gilman, President.

Goodyear Aircraft Corp., Akron, Ohio 201
Exhibiting: GEDA line of analog computing equipment.
In attendance: H. P. Partenheimer, Mgr. Radar and Electronic Sales; J. A. Rudolph, K. H. Starks, GEDA Field and Customer Service.

Hammarlund Mfg. Co., Inc., New York 1, N. Y. 216
Exhibiting: New Products—Amplitude-modulated continuous telemetering system to accommodate 40 or more readings on single circuit. Modular type plug-in audio tone units. **Regular Products**—Multi-gate supervisory control equipment; control and signalling equipment.
In attendance: Robert B. Moon, Gen. Sls. Mgr.; C. L. White, Chf. Laison Engr.; Chet Menkes, Sls. Engr.; S. H. Van Wambeck, Chf. Engr.; Dale Samuelson, Sls. Prom. Mgr.

Heat Timer Corp., New York, N. Y. 215
Exhibiting: Time-recorder-totalizer; time totalizer; electronic smoke control; electrically operated valves; electronic heat control; electronic fire alarm.
In attendance: Edward J. Zeitlin, Pres.; Harry Zeitlin, V. P.; Al Fowler, Production Engr.; Bert Lief, Adv. Mgr.; Lee Leighton, Chf. Engr.

Hewlett-Packard Co., Palo Alto, Calif. 415
Exhibiting: See listing for RMC Associates.

Hillyer Instrument Co., Inc., New York 13, N. Y. 705, 707
Exhibiting: Automatic drilling machine, automatic tape controls.

Hycor Sales Co., North Hollywood, Calif. 406
Exhibiting: See listing for Burlingame Associates, Ltd.

Infra Electronic Corp., Roseland, N. J. 416
Exhibiting: Phase angle and precision turns measuring sets; precision lamination notching press; synchros, servos, electromechanical test equipment.

Institute of Radio Engineers, New York 36, N. Y. 609
Exhibiting: Publications of the IRE, emblem pins, standards, membership applications, IRE information.
In attendance: William C. Copp, Adv. Mgr.; Lillian Petranek, Asst. Adv. Mgr.; Emily Petranek.

Instrument Components, Inc., College Point, N. Y. 605
Exhibiting: New Products—Ball and disk integrator for computing systems, variable speed drive; high-speed magnetic clutches, and remote control positioner for shaft positioning. **Regular Products**—Gears, differentials, couplings, positioners, clutches, dial assemblies, grid plates and accessories.
In attendance: J. G. Cunningham, Sls. Mgr.; G. L. Pross, Chf. Engr.; J. F. Cardinal, Adv. Mgr.; John Tone, Chf. Consulting Engr.

For more information on Exhibitors products write booth number on inquiry card.

Booth No.

Instruments, Inc., Tulsa 3, Okla. 715
Exhibiting: New Products—Capacitance product analyzer for continuous recording of pipeline contents. Capacitance-operated level switch. **Regular Products**—Devices for liquid level control, density and level, non-destruction measurement of pipe-wall thickness; electronic level switch; pneumatic transmitter.
In attendance: Karl T. Ball, Sls. Mgr.; Charles H. Limerick, Asst. Sls. Mgr.

Instruments Publishing Co., Inc., Pittsburgh 12, Pa. 103
Exhibiting: Publications—"Instruments & Automation"; "Instrument & Apparatus News"; "Instrument Manufacturing." **Buying directories**—"The Instruments Index" and "The Instrument Manufacturing Guide." **Books**—"The Handbook of Measurement and Control"; "Process Control"; "Nuclear Reactors for Industry and Universities"; "Electronic Circuitry for Instruments & Equipment."
In attendance: Richard Rimbach, Richard Rimbach, Jr., Robert J. Donnelly, Melvin J. Nervie, Martha Rimbach, Gretchen Rimbach.

International Business Machines Corp., New York, N. Y. 119
Exhibiting: Electronic computers.

Kay-Lab, San Diego, Calif. 415
Exhibiting: See listing for RMC Associates.

Kaye Development Co., Stamford, Conn. 603
Exhibiting: Trichrometer—continuous color process control.

Kellogg Switchboard & Supply Co., div. of International Tel. & Tel. Corp., Chicago 3, Ill. 315
Exhibiting: New Products—Multi-position decade counter responding to random or cyclic pulse rates to 20 pulses per sec. **Regular Products**—Switches, relays, and other equipment associated with telephone industry.
In attendance: H. F. Van Zandt, Asst. Sls. Mgr.; R. Rosenkoetter, Industrial Sls. Engr.; R. H. Williamson, Appl. Engr.; O. J. Berger, Jr., Jack Boeing, Preston Mack, Francis J. Gamble, Sales Reps.

Kleinschmidt, Inc., Deerfield, Ill. 403
Exhibiting: Page teleprinter, typing reperforator and tape transmitter, tape transmitter. **Services**—Design, development and manufacture of high speed printing communications equipment and systems, tape punches and readers.
In attendance: C. J. Lambert, Sls. Div. Mgr.; N. J. Geiser, Sls. Engr.; Robert R. Vehe, Sls. Service Mgr.

Kybernetes Corp., New York, N. Y. 105
Exhibiting: High-speed electronic scanning and monitoring system with dynamic visual presentation on single c-r tube of related process variables showing instantaneous changes in magnitude as well as process trends.
In attendance: Mark Probst, Sales Engr.; Sal DiCecio, Chf. Engr.; Ira Schulman, Sales Engr.; John E. Kamak, Sales Rep.; Edward Grace, Consultant-Insts.; H. Everett Smith, V.P.

Laboratory for Electronics, Boston, Mass. 406
Exhibiting: See listing for Burlingame Associates, Ltd.

Labscope, Inc., Carlstadt, N. J. 406
Exhibiting: See listing for Burlingame Associates, Ltd.

Larson Instrument Co., Tarrytown, N. Y. 318
Exhibiting: New Products—Inkless recorders, single and multi-channel (to 30 styluses). **Regular Products**—Smoke-dust indicator control, recorders and controllers, contact meters, central control systems, voltage breakdown tester (mobile). **Services**—Complete automatic control systems with custom bench or console.
In attendance: Louis H. Larson, Chf. Engr.; Claude A. Gates, William D. Laverell, R. A. Reitz, R. A. Reitz, Jr., G. E. Adam, Stewart Miller, Lyle F. Howe, Sls. Engrs.

P. M. Lennard Co., Inc., Brooklyn 38, N. Y. 303
Exhibiting: Dust and atmosphere control assembly hoods.
In attendance: Paul M. Lennard, Pres.; Leonard Music; Julian H. Kushnick, Res. & Dev. Engr.

Magnecord, Inc., Chicago 24, Ill. 713
Exhibiting: Magnetic-tape recording equipment.

Magnetic Research, Inc., El Segundo, Calif. 406
Exhibiting: See listing for Burlingame Associates, Ltd.

Metrotype Corp., Summit, Ill. 2208
Exhibiting: Metrotype digital recording.

Nash Engineering Co., South Norwalk, Conn. 316
Exhibiting: Air compressors for automation.

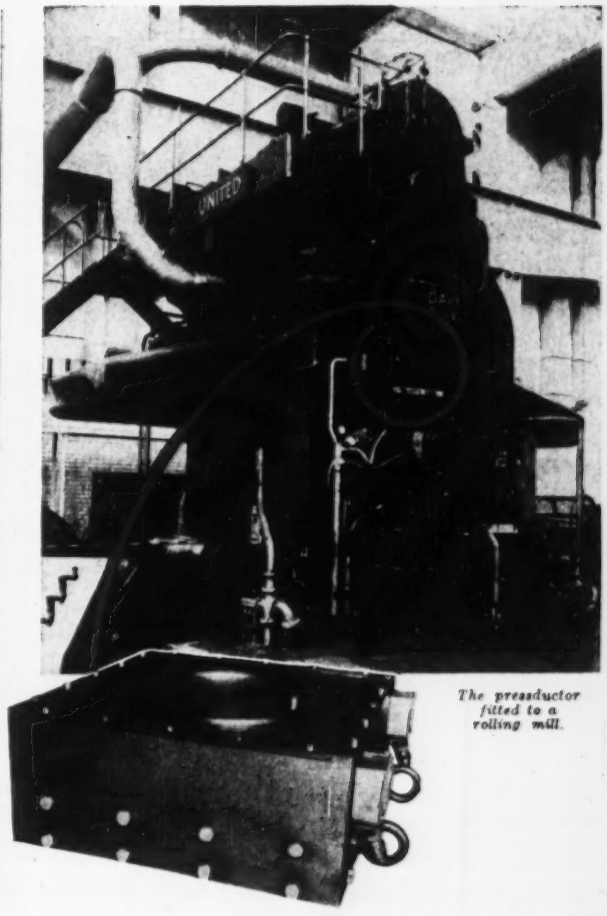
Panellit, Inc., Skokie, Ill. 217, 219
Exhibiting: New Products—Information systems that automatically log process conditions, continuously monitor variables, provide signal and readout. **Regular Products**—Annunciators. **Services**—Development and manufacture of graphic panels, central control rooms, data processing and data reduction systems; information systems.
In attendance: A. F. Sperry, President; M. D. Shriver, Gen. Sls. Mgr.; G. S. Daniels, R. Marmorstone, Engineers.

Parker Appliance Co., Cleveland 12, Ohio 703
Exhibiting: New Products—Directional control valves for machine-tool and other hydraulic production equipment; piston-type hydraulic accumulators. **Regular Products**—Hydraulic check valves, hose fittings and assemblies, tube fittings, tube working tools, synthetic rubber o-rings.
In attendance: D. A. Cameron, Ind. Sls. Mgr.; S. E. Voran, Adv. Mgr.; C. E. Klamm, Tech. Asst. to Pres.; K. E. Jenkins, Indus. Hyd. Sls. Mgr.; W. D. Wynant, Tube & Hose Fittings Sls. Mgr.; H. A. Ludlam, District Mgr.; R. N. Boucher, H. H. Walley, Sls. Engr's.; R. B. Jewett, District Mgr.; Paul Kozak, Asst. Adv. Mgr.

Post Machinery Co., Electronic Products Div., Beverly, Mass. 220
Exhibiting: Electronic counters and controls.

Potter Instrument Co., Inc., Great Neck, N. Y. 621
Exhibiting: New Products—Demonstration of automatic control via dual-sequence predetermined electronic counters. **Regular Products**—Digital magnetic-tape handler, interval timer, digital teledeltos recorder, predetermined counter, frequency-time counter. **Services**—Analysis and design of automatic control systems where process can be defined as a number of discrete electrical impulses.
In attendance: John J. Wild, V.P.; John B. Flynn, A. C. VenDitto, Sales Engrs.

For more information write booth number on inquiry card.



The pressductor fitted to a rolling mill.

ASEA *presents*

The Pressductor — for non-electronic industrial pressure measurements, e.g. on rolling mills.

The Torductor — for torque measurements on large shafts without metering elements attached to, or in contact with, the shaft.

The ASDET Metal Detector — for various metal detecting purposes, including detecting tramp metal in magnetic ore. No balancing.

Air-cooled High-Vacuum Pump — for receptacles which are to be kept under constant vacuum, for small vessels that have to be repeatedly evacuated, or for general laboratory uses.

U. S. representatives:
AROS ELECTRIC, INC.
16 East 71st Street
New York 21, N. Y.

ASEA

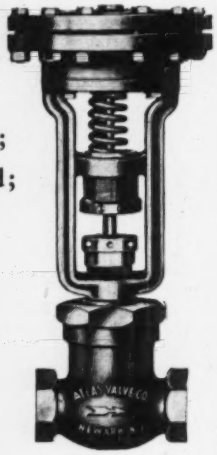
Vasteras • Sweden

For more information circle **42** on inquiry card.

ATLAS

TRADE MARK REG.

Type "D" REDUCING VALVES



Spring Loaded;
Diaphragm Operated;
Externally Controlled;
Single Seat;
Simple;
Direct or Reverse Acting;
Easy to Operate;
Initial Pressures to 600 p. s. i.

Users are Pleased

For several reasons users of ATLAS Type "D" valves are invariably pleased. First, if you will study the sectional view in our Bulletin 1-A (Ask for a copy), you will find that it is unusually simple in design and construction. It always gives accurate and close regulation of pressures. It is easy to inspect. The single seat is provided with renewable discs of composition or metal. The valve stem is of stainless steel. Diaphragm is reinforced neoprene. Controls the pressure of steam, gas, hot oil, or hot water where a simple tight seating valve is required. Durable. Bronze or steel body.

Bulletin 1-A

This 52-page bulletin should be in the files of every user of valves. It includes complete data on Type "D" and many other ATLAS types—pressure reducing valves—lever operated balanced valves—auxiliary operated pressure regulating valves—strainers etc.

ATLAS Engineers

Our engineers will gladly work with you on any valve regulating problem. We have been in the regulating valve business for more than 50 years. Our engineers are specialists in this field.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
292 South St. Newark 5, N. J.
Represented in Principal Cities

For more information circle **43** on inquiry card.

EXHIBITORS—CONTINUED

Booth No.

Radio Frequency Laboratories, Inc., Boonton, N. J. 206
Exhibiting: New Products—2-wire 4-wire telephone terminal for fixed plant two-way radio circuit transmission. Duplex audio telegraph terminal to convert coded d-c. pulses to frequency shift audio signals and vice versa. Duplex data transmission terminal to operate on various lines and circuits. **Regular Products**—Telegraph carrier terminal. **Services**—Design and development of signalling equipment relative to automation.
In attendance: E. A. Gilbert, Engrg. V. P.; H. H. Emker, G. King, R. Gilman, Electrical Engineers.

Radio Frequency Laboratories, Inc., Boonton, N. J. 307
Exhibiting: New Products—A-c. d-c. instrument calibration equipment; Magnetreater, for use with magnet charger in adjusting degree of charge in remagnetized instrument core. **Regular Products**—Magnet charger. **Services**—Design special magnet charging fixtures.
In attendance: R. H. Denton, J. F. Falk, Vice Presidents; D. S. Kromka, Sales Engineer.

Remington Rand, Inc., New York, N. Y. 319
Exhibiting: Electronic computers.

RMC Associates, New York City and Bogota, N. J. 415
Exhibiting: New Products of Kay-Lab (industrial TV system, decade amplifier, d-c. microvoltmeter); Hewlett-Packard (VTVM, decade sealer); Beta Electric (two-section high voltage supplies). **Regular Products**—Hewlett Packard (audio oscillator, frequency meter, tachometer generator, and head assembly, electronic counter); Beta Electric (high voltage insulation testers, h-v. supplies).
In attendance, Robert Asen, Milton Lichtenstein, Charles Sargent, Harold Plamjack, Robert MacVeety, Field Engrs.; Robert Adams, Victor Wouk, Sanford Glassman, Jesse Stitzer, Noel Eldred, Leonard Cardoza, Engineers.

George Scherr Co., Inc., New York 12, N. Y. 414
Exhibiting: Optical instruments—comparators, amplifying gages, dividing heads, rotary tables, toolmakers microscopes. Small toolroom specialties—calipers, surface plates, gages blocks, etc.
In attendance: George Scherr, Pres.; F. Koenig, Sec.; A. A. Crystle, Sls. Mgr.; E. R. Schwengber, Mgr. and W. J. Cross, Asst. Mgr. Small Tools Dept.

Sheffield Corp., Dayton 1, Ohio 717
Exhibiting: Production gaging and inspection equipment (air, electric, electronic, mechanical) for automatic and semi-automatic operation. Control units and circuits for automatic size control on machine tools. Precision gaging instruments, thread grinders, taps, welding and deburring machines.
In attendance: Carl Linxweiler, Adv. Dir.; W. Fay Aller, Dir. of Research; William I. Wilt, Asst. Sls. Mgr.; Dave McConnell, Asst. Dir. of Research; Elwood Byrkett, Supvr. of Res. Engrg.

Sorensen & Co., Inc., Stamford, Conn. 405
Exhibiting: New Products—A-c. meter calibrator, d-c. voltage standard. **Regular Products**—a-c. line voltage regulators, regulated d-c. supplies, frequency changers.
In attendance: Edward R. McCarthy, Sls. Mgr.; Kurt Haller, Asst. Sls. Mgr.; Nat Magida, Appl. Engr.; L. L. Helterline, Jr., Gen. Mgr.; Adolph Bunblasky, Chf. Prod. Engr.; RMC Associates.

Standard Electronics Research Corp., New York 21, N. Y. 615
Exhibiting: New Products—Miniature diameter measuring unit; drift-free beta thickness gage. **Regular Products**—diameter measuring unit; fuze and shell inspection gages. **Services**—Research and development in automatic measurement and control in production of wire, cable, rubber and plastic sheet, foil. X-ray inspection of shells.
In attendance: Dr. Frederic Fua, Dir. of Res.; M. N. Kirby, Sls. Mgr.; B. W. Olson, New England Sls. Rep.; H. Jackson, Engr.

Superior Electric Co., Bristol, Conn. 202
Exhibiting: Variable transformers and automatic voltage regulators for all applications.
In attendance: R. Link, B. G. Deming, P. James, R. J. Fiorente, Sales Engineers; J. S. Louden, Sls. Mgr.; F. Molander, Display Mgr.; R. Hampson, D. Calloway, Exhibit Personnel.

Taft-Pierce Mfg. Co., Woonsocket, R. I. 417
Exhibiting: Display model of automation gaging—air-electric unit will automatically gage cylinder bore of small-scale engine blocks on moving belt; control panel gives dial and light indication of part size. **Regular Products**—Computing, line-type, and wide tolerance air gages; plug, ring, and snap gages.
In attendance: F. Steele Blackall, III, Asst. Gen. Mgr.; Franklin Meyer, Jr., Chf. Engr., Instr. Gages; F. Curtis Fales, Gage Engr.; Clinton Jacks, Service Engr.; Kenneth G. Wheeler, Wendell F. Carney, Charles D. Toomey, Sls. Engrs.; Richard F. Coe, Adv. Mgr.; Clifford Stead; Prod. Dev. Engr.

Techniflex Corp., Port Jervis, N. Y. 115, 117
Exhibiting: Motor control for electronic braking, instrument responsive all-electric valve operator.

Teletype Corp., Chicago 14, Ill. 301
Exhibiting: New Products—60-character-per-second communication system consisting of: tape reader, electronic transmitting distributor, receiving distributor, control unit, high-speed punch (reperforator). **Regular Products**—Page printer, tape transmitter distributor.
In attendance: M. T. Goetz, V. P. Sales; J. C. Peltier, Sls. Mgr.; C. W. Burcky, Engr., Prod. Appl.; R. B. DePoy, R. A. Larsson, J. A. Michels, J. J. Seifried, Engineers.

Trincor, Inc., Roselle Park, N. J. 320
Exhibiting: New Products—Industrol dynamic dehumidifiers with "finned-system" drying chamber; dehumidifiers for automatic dehydration of gas sampling systems; "Trin-vue" sight flow indicators; Trinity double-bore thermowells; welded thermocouples. **Regular Products**—Dehumidifiers, adsorptive filters, desiccant type absorbers, process pilot plants, thermowells, test wells, tubes, thermocouple assemblies.
In attendance: George R. Feeley; James V. Mannion; Robert C. Axt; Robert E. Hyer; Edward M. Feeley; Maynard S. Northup.

Uehling Instrument Co., Paterson 3, N. J. 305
Exhibiting: New Products—Tel-Flo meter for measuring flowrates and purging line, pressures to 300 lbs. **Regular Products**—Indicators for liquid level, vacuum, pressure; barometers; draft gages; manometers; vacuum and absolute pressure recorders.

For more information write booth number on inquiry card.

In attendance: Peter J. Riccobene, Sls. Mgr.; Alexander M. Foth, Russell A. Kithcart, Sls. Engrs.

Victor Adding Machine Co., Chicago 18, Ill. 304

Exhibiting: VIC-DAR electronic digital conversion of analog voltage to unitary or binary count, for machine control, listing of information, card or tape punching, mathematical operations, or injection of control information.

In attendance: R. R. Howard, Mgr. Vic-Dar Div.; George Hasbach, Mgr. Negotiated Div.; Stanley Molner, Eugene Heal, Sales Engineers.

Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., New York 17, N. Y. 203

Exhibiting: New Products—Fully automatic Rockwell hardness tester, testing and sorting into correct hardness 1000 to 1200 pieces per hour, manually or automatically fed. **Regular Products**—Rockwell testers.

In attendance: V. E. Lysaght, Sls. Mgr.; O. H. Shettler, N. Y. Rep.; J. Addison, Phila. Rep.; E. Rave, W. Leopold, Factory Reps.; C. McCarthy, Service Rep.; T. D'Uva, Sls. Dept. Rep.; S. P. Rockwell, New England Rep.; C. E. Bennett, Syracuse Rep.

Zenith Electric Co., Chicago 10, Ill. 418

Exhibiting: New Products—Process timer with percentage timing for temperature control of radiant type heaters; explosion-proof interval timer. **Regular Products**—Interval, cycle, program timers; time, transfer switches; magnetic contactors; motor starters.

In attendance: Lew Coren, Owner; Chas. Kraut, N. Y. Rep.; Jim Wyatt, Phila. Rep.

For more information on Exhibitors products write booth number on inquiry card.

ISA Show Reveals New Trends

FIRST International Instrument Congress and Exposition was held September 13-24 in Philadelphia. This city, home of Constitution Hall and a city closely associated with the great ideals that led to the formation of the United States of America, was a particularly appropriate setting for the event; the presence of many foreign exhibitors and visitors pointed up the oneness and smallness of our world, and the need for greater understanding and cooperation between all nations.

The vast size of the exposition and conference (490 exhibitors, 66,934 square feet of exhibit space, over 250 technical papers, 22,987 registered attendance) makes it impossible to report all the new instruments at the show. We will confine our report to those developments that define trends in the field—plus our impression of foreign (European and Japanese) exhibits.

The Digit

Outstanding and obvious was the trend to digital representation of data. In far greater amount than in any previous show, instruments were shown with "digital readout." Digital displays were shown with mechanical counters, glow tubes, "Inditrons," edge-lighted plastic-engraved numbers, "Trochotrons," automatic typewriters, automatic printers, "scoreboard" readout, beam-switching tubes, "E1T" decade counters, and coded lights.

The new "Inditron" (made by National Union) was shown in the Metrotype display of digital indicators, scanners, and recorders. The "Inditron" uses ten shaped neon-discharge tubes, each shaped into a digit from 0 to 9, and stacked one behind the other.

Lovely engraved numbers on edge-lighted plastic plates were exhibited in the Wiancko DIBA (digital internal ballistics analyzer).

The Swedish "Trochotron" readout device has a series of glow tubes arranged around the perimeter of a small plate engraved with the numbers 0 to 9. It was shown in the Swedish LKB scaler and pulse counter, featuring counting speeds of 1 million pulses per second.

Streeter-Amet added to their well-known automatic weight printers with a "scoreboard" readout. This is a large board with many lights; appropriate lights are energized to form a large number visible at considerable distance.

The console-type centralized-control desks (heart of the graphic panel of tomorrow) of Panellit featured digitized readout; the Taller & Cooper "Autolog" was shown recording and monitoring many plant operations in digital form, as was the Fischer & Porter data logger.

Other forms of digital readout included a Speedomax plus Giannini Encoder plus Clary typewriter (Leeds & Northup exhibit); digital temperature logger with "Digi-Coder" converter plus "Flexowriter" typewriter (Fischer & Porter display); precision pressure balance with accuracy of best mercury manometer and with digital readout (Consolidated Engineering); 5-hole teletype code to X-Y recorder via punch-tape converter (Librascope display); flow indication with turbine-type flowmeter plus mechanical counter plus glow-tube counter (Potter Aeronautical); ratemeter with "E1T" decade counter tube (Curtiss-Wright display); high-speed counting with beam-switching tubes (Burroughs display); electronic indicators with digital readout (Allegany exhibit); and others. A mechanical register which can count to 300 impulses per second was exhibited by LKB-Produkter (Sweden).

Increased emphasis on digital readout has produced increased interest in analog-to-digital converters. Great interest was shown in the F&P "Digi-Coder," the Kearfott "ADAC," the Giannini "Angular Position Encoder," the "Reacon" converter of J. B. Rea, and other converters.

Valve Operators

The basic pneumatic-motor valve operator is in no danger of obsolescence—but interest is high in new operators that might provide greater forces, longer strokes, and higher speed. This is an important frontier in process instrumentation.

New techniques for use of electric valve operators were disclosed by Techniflex—particularly use of "plugging" (for rapid stopping of the motor) and impact-load relief devices. These developments warrant much attention.

An experimental electro-hydraulic valve operator of Manning, Maxwell & Moore also was of great interest; and your reviewer suggests the possibility of the use of the exhibited electro-jet of Askania, plus servo components, as a basic electro-hydraulic valve operator.

Emphasis in these devices will increase as throughput rates increase and challenge the abilities of pneumatic operators. The fact that pneumatic operators will not view the challenge of electric and hydraulic operators with equanimity is found in the Conoflow cylinder operator, which uses 100-psi. air to obtain high-frequency response plus long strokes at high thrust.

New Principles and Instruments

One new device with large potentialities is the Decker "ionization transducer," comprising a glass envelope (containing gas that is ionized by an RF field) and two internal probe electrodes. Space charges developed on the two electrodes are a linear function of electrode *position* and *capacitance*. Hence large signals are developed by small changes in pressure, displacement, dielectric, conductivity, and other variables to which the small probe electrodes are coupled.

An important new principle in high-speed photography was revealed in the "CP600" high-speed camera, developed in England but to be made and marketed in the U. S. by Hathaway Instrument Co. The optical system enables pictures to be taken at rates in excess of 100,000 per second; 200 discrete pictures can be recorded. This is achieved by use of an assembly of small lenses (80,000) embossed in plastic and bonded to a glass plate (a lentic-

A few of the 22,987 persons who attended the First International Instrument Exposition.

ular plate). The lenses dissect the picture into a large number of small elements; the displacement of each picture element is produced by altering the direction in which light falls on the assembly of lenses—this being achieved by a Nipkow disc (rotating disc with apertures at appropriate intervals). The complete series of pictures is recorded on an ordinary 4 x 5 inch photographic plate, which is replaced in the film holder after it is developed. After replacing the photographic plate in the holder, a bright light is introduced in the camera lens, which produces a silhouette on a ground glass screen at the rear of the carrier. Slow rotation of the Nipkow disc reveals "still" views of the high-speed series of photographs. The aperture disc can be stopped at any desired position and a simple contact print made of the event at any stage of the action photographed. We consider this to be one of the most important new developments at the show.

Also in the field of data recording were noteworthy developments in magnetic tape recording and cathode-ray oscillography—tape recorders were displayed by Ampex, Davies Labs., Potter Instrument, and others. A new technique in cathode-ray oscillography was revealed by Wm. Miller Instruments in their new "CR-1" high-frequency (250 kc.) recording system.

A brief mention of a few instruments of particular significance includes (1) the Minneapolis-Honeywell servo-analyzer for rapid analyses of control loops, (2) the Builders-Iron Dall flow tubes featuring low head-loss, (3) the G. E. potentiometer with magnetic standard (this proved to be of great interest to European and American instrument users), (4) the automatic quality-control equipment exhibited by Barnes Development, (5) the complete new line of German, Swiss, and English electronic test instruments revealed by Federal Telephone and Radio, (6) the new-principle variable-area flowmeter combining simplicity of orifice with linearity and viscosity-insensitivity of the variable-area meter, exhibited by Devic-Engineering Co., (7) the variable-scale counter that can count by any number from two to ten, exhibited by Burroughs Corp., (8) inverter-chopper "Syncroverter" for low-noise-level chopping of d-c. signals, exhibited by Bristol Co., (9) Varitrol speed controller for motors, featuring pneumatic amplifier, exhibited by U. S. Electrical Motors, (10) gas analyzer using detection of mercury vapor in ultraviolet light to get parts-per-billion analysis or air for combustibles or poison, exhibited by Taller & Copper, (11) the McIlroy pipeline-network analyzer, exhibited by Standard Electric Time Co., (12) Sinclair-Phoenix forward-scattering aerosol and smoke photometer for air pollution, exhibited by Phoenix Precision Instrument Co., (13) gyro mass meter of Norwood Controls, (14) the "Little Sam" sampling valve of Jordan Regulator Co., (15) the cycloidal focusing mass spectrometer of Consolidated Engineering, (16) commutatorless d-c. motor of Brailsford & Co., (17) the complete new line of TV test equipment introduced by Weston, (18) the magnetic flowmeter of Foxboro, (19) the Series 60 electro-pneumatic control system and the panel-mounted pH Meter of Leeds & Northrup, (20) the mass flowmeter of Potter Aeronautical, (21) the high-sensitivity infrared "Ektron" detectors of Eastman Kodak, (22) the infrared viewer of Farnsworth Electronics, (23) the infrared viewer of Servo Corp. of America, (24) motor-control system of Reliance Electric, which uses a Swartwout "Autronic" controller, (25) new "McCannameter" metering pump of Hills-McCanna, (26) air-study instruments of Bendix-Friez, (27) "Arithmometer" automatic blood-count instrument of Jarrell-Ash, (28) educational cloudchamber films of W. M. Welch, (29) wide-range chlorinator of Wallace & Tiernan, (30) pneumatic transmitter with suppressed range of Manning, Maxwell & Moore, (31) curved-crystal X-ray spectrometer of ARL, (32) precision voltmeter and phase comparator of Link, (33) 12-channel electronic switch of Century Geo., (34) redesigned receiver-recorders of Bailey Meter, (35) pneumatic computer of Taylor, (36) 3-element boiler-feedwater controller of Hays, (37) electronic test instruments of Measurements Corp., (38) the "Massometer" of Wallace & Tiernan, (39) the recorder of West Instrument, featuring magnetic amplifier, (40) the "Varec" pulse-code telemetering system, (41) the "Metrisite" variable-reluctance micrometer gage of Graydon Smith, (42) the Fielden d-c. amplifier featuring servo operation and feedback directly to the moving-coil element, (43) the electrical-

A few of the 499 booths at the First International Instrument Exposition which covered a total of 66,934 sq. ft.

instrument calibration equipment of Radio Frequency Labs., (44) line-operated pH meters of Photovolt, (45) the large G-accelerator centrifuge of Genisco, (46) the 30,000-psi. pressure-reducing valve of Fisher Governor, (47) the X-V series of "Flex-Valves" of Farris Engineering, (48) the d-c. amplifier of Doelcam, featuring 2nd-harmonic magnetic converter, (49) transistor batteries of Burgess, (50) thermal-conductance-type analyzers for ternary mixtures of gases, exhibited by Mine Safety, (51) "NATECS" traffic control system of North American Aviation, which clears traffic from intersections for a quarter-mile ahead of emergency vehicles, (52) new viscosimeter principle based on loss of head in flowing sample between two fixed restrictions, exhibited by Commercial Research Labs, (53) world's smallest practical (pencil-ferrule-size) electric motor, exhibited by Hamilton Watch, (54) industrial servo system of Raytheon, which combines electric (magnetic-amplifier type) amplification with hydraulic power operators to effect control of powers from 1 to 150 hp., and many, many others which can not be mentioned because a total list would fill this magazine. The reader is urged to refer to the "New Products" Department of this magazine, where many of the hundreds of new instruments exhibited are reported in detail.

Telemetering

More complete automation of all operations is leading to increased emphasis on telemetering. Penn Industrial displayed flowmeter receivers whose transmitters were located at the Penn factory and connected over telephone-line circuits. Foxboro exhibited their new "Teletax" telemeter of the impulse-duration type. New Bristol "Metameter" telemeters were shown in actual operation, receiving and controlling field installations; Bendix-Pacific displayed a new "Electro-Span" digital supervisory control system for controlling and telemetering 30 functions.

Scanning, Monitoring

Another "growth frontier" in automatic operations is scanning and monitoring of process variables. The amount of data now required of central control stations exceeds the amount that can be individually watched and recorded. This function is being taken over by the monitor-scanner, which gives an alarm when any of its many preset variables exceeds limits. Scanner-monitor systems were exhibited by Taller & Cooper, Panellit, Fischer & Porter, Kybernetes, Fielden, Edison, and others. The Kybernetes scanner introduces a new concept of electronic scanning and puts the cathode-ray tube on the control panel. The Fielden unit is a 114-point scanner-annunciator with set-point facilities for each point.

Transistors

Add one more year—1954—in which the transistor has given no serious competition to the vacuum tube, although several transistorized amplifiers were exhibited (Raytheon, Daystrom, Minneapolis-Honeywell, etc.). Great interest was aroused by the new power transistor of Minneapolis-Honeywell with 5-ampere collector characteristic and current gain of 30. A "natural" application for a transistor is in the new Fielden "Tektor" tube and probe, in which the probe has an RF oscillator built into the head—yet a vacuum tube is used.

Foreign Impressions

Most foreign industrial millivolt recorders are of the chopper-bar type now obsolete in America; yet all other foreign techniques are comparable to ours. The English concept of "intrinsic safety" as well as "explosion proof" permits wider use of electronic control systems and is now under consideration by American Committees on safety standards. (We will report more on this subject of Instrinsic Safety.)

The English "Mimic" panel (graphic panel) with "Inline" indicators was of interest. The Swedish "Minigraf" jet galvanometer, which uses a fine jet of ink to record and thus eliminate the friction of a pen on paper, was shown with response speed to 1000 cps. The Swedish "Sinus" vibrometer measures vibration without amplifiers; the Swiss "Tesamaster and Tesatest" micrometer gages with direct-reading verniers eliminate mental calculations usually associated with vernier interpolation; fine electronic and optical techniques were displayed in the Japanese electron microscope (of which 200 are in use in Japan).

The largest Foreign exhibit was the French; joint exhibits represented over 40 companies. Two French instruments vied for the title of "chief show attraction"—an original Bourdon pressure gage made in 1849, and (not a historical curiosity) a 10-inch strip-chart six-channel recorder with part of the chart serving as a projection screen; every five seconds the channel number and its reading would be projected on the chart, being readable from 40 feet (La Pyrometrie Industrielle).

The principal English exhibit (apart from single-company booths) was that of the Scientific Instrument Manufacturers' Association (SIMA); 21 companies participated. Of particular interest: (1) reflecting microscope of R. & J. Beck, (2) interference microscope of C. Baker, (3) infrared spectrometer with new Merwyn grating, with 85 percent of energy in 3-micron region, exhibited by Merwyn Instruments, (4) anemometer of Isotope Developments, Ltd., using alpha-particle ionization technique, (5) new standards for calibrating electrical instruments, by Elliott Brothers.

The Month's NEW INSTRUMENTS

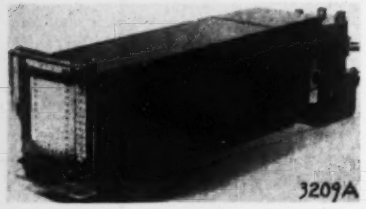
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1865

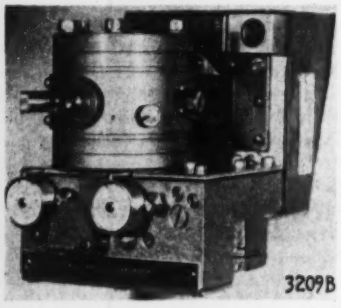
PROCESS CONTROL

Miniature Pneumatic Instrumentation

New improvements in "Tel-O-Set" line of miniature pneumatic instruments include the following: (I) Recorder: Transfer switch and air regu-



lator knobs are located at bottom, allowing clear view of chart record and all scale pointers while adjustments are being made. With catch released, chassis can be completely removed. Air and electrical connections are broken by means of quick-connect screw-type plugs. (II) Controller: Quick-connect facilities permit any adjustable-band "Tel-O-Set" controller to be mounted directly on a "Tel-O-Set" recorder or, when equipped with a manifold, mounted remotely back of panel or in the field. New arrangement permits adjustments to be easily accessible and guarantees that air lines



will be sealed before controller is removed so that system can still be operated on manual control. (III) Varied Reset Rates: Only one basic controller model is required for all applications. (IV) Remote Mounting: Basic controller model can be mounted in any location without loss of "bumpless" manual-automatic switching. (V) Controller Operation: Deviation section is now at top; proportional band circuit feeds directly into positive feedback chamber; new circuitry eliminates 1:1 relay found in previous models.—*Industrial Div., Minneapolis-Honeywell, Philadelphia 44, Pa.*

For more information circle **201** on inquiry card.

CONTENTS OF THIS DEPARTMENT

Process Control	1726	Electrical Testing	1752
Temperature and Humidity	1727	Electrical Instruments	1753
Flow and Volume	1729	Electr.-instrument Accessories	1758
Pressure, Vacuum	1730	Amplifiers	1760
Force, Load	1732	Power Supplies	1761
Level	1734	Electrical Components	1763
Displacement	1736	Electromechanical Components	1773
Time	1737	Mechanical Components	1777
Nucleonics	1738	Valves	1779
Computing	1740	Miscellaneous	1781
Laboratory	1742		
Dimensional	1746		
Mechanical Testing	1748		

Heat-flow-factor Calorimeter

New model of "Sigma Calorimeter" (made in England) has been modified so that it records directly and continuously in terms of heat flow factor instead of Btu. Major change is in instrument's regulator: previously, it kept a constant flow of gas through instrument despite changes in specific gravity; new regulator permits flow of gas inversely proportional to square root of specific gravity, so that heat available at burner is proportional to heat flow factor. Use of new recorder obviates need for spot checking specific gravity and Btu. value and making calculations. When new instrument is combined with pneumatic control, it can adjust mixing of two gases and keep heat flow factor constant; it can also be fitted with alarm contacts.—*Cosa Corp., 405 Lexington Ave., New York 17, N. Y.*

For more information circle **202** on inquiry card.

Chlorine Gas Feeder

New "Model EVS Chlorinizer" visible-flow chlorine gas feeder is available in capacities of 4 to 400 lbs. per 24 hrs. with a metering range of 8 to 1 and an accuracy within 4 percent. It stands 66 in. high, is 17 in. wide and 12 in. deep; features a panel with recessed, eye-level "Sightflo" indicator, flush mounted gages for chlorine and injector supply pressures, and adjustment knobs for chlorine feed rate and tray water flow; also automatic safety features; elimination of chlorine ice troubles; and short chlorine path containing no springs, stuffing boxes or piloted mechanism.—*Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.*

For more information circle **203** on inquiry card.

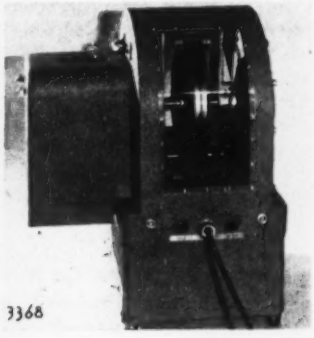
Program Controller

New "Gardsman Model JG" program controllers assure "completely automatic process control of any time-temperature cycle with off-on, proportioning, high limit or stepless control action plus secondary control action." Temperature control is obtained through use of a flag on indicating pointer which interrupts light beam between a photocell and light source mounted on setting arm. Photocell output is amplified by a magnetic amplifier: no tube burn-out, no circuit tuning, no warm-up period. User can also start or stop cycle at any predetermined time or operate auxiliary equipment at any point in cycle.—*West Instrument Corp., 525 N. Noble St., Chicago 22, Ill.*

For more information circle **204** on inquiry card.

Process-control Memory

New "Proportional Syncronizer" stores a reading of varying magnitude and reproduces this quantity at a later period in a process, synchronized with

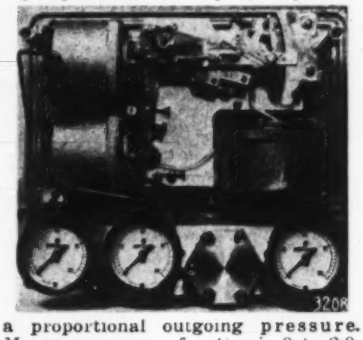


speed or movement of processing line. In operation, a reading from a measuring instrument is applied to memory unit through a self-balancing system. Memory unit is driven from process line in the same relation that material is progressing through process, and advancement of information on memory unit is in relation to this movement in both speed and distance.—*Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford 1, Conn.*

For more information circle **205** on inquiry card.

Adjustable-ratio Air Control Relay

New "Tel-O-Set Automatic Ratio Relay" can multiply two different input pressures (3-15 psi.) to provide

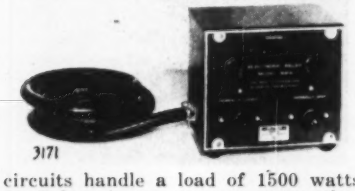


a proportional outgoing pressure. Maximum range of ratios is 0 to 2.0, which corresponds to 3-to-15-psi. change in ratio setting pressure. (However, ratio span may be changed to any desired value within this range).—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **206** on inquiry card.

Process-control Relay

New "Model 300A" electronic relay for use in control applications will operate on a closure through a resistance of several megohms. Output

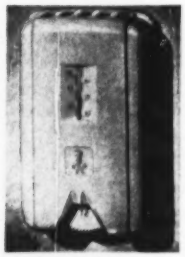


circuits handle a load of 1500 watts or 2 hp. Announcement states that "temperature can be controlled, using heating and cooling cycles, to better than 0.005 C." Low short-circuit current (less than 1 microamp.) and open circuit voltage of approx. 6 volts prevent contact deterioration.—*Deltron, Inc., 2905 Leithgow St., Philadelphia, Pa.*

For more information circle **207** on inquiry card.

TEMPERATURE AND HUMIDITY

Thermostat for Electric Heating



New thermostat for electric heating, including radiant panels, wall heaters and other types, is actuated by a powerful metal bellows which responds quickly to temperature changes; maintains temperatures between 64 F. and 80 F. with a maximum operating differential of 2 F. Rating 20 amps. (non-inductive load) at 125 or

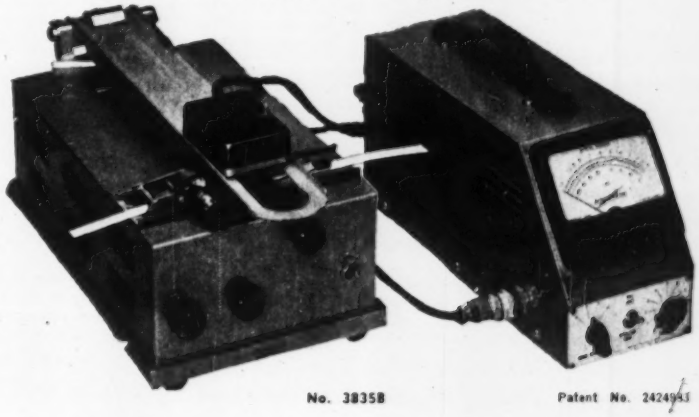
TRANSMISSION DENSITOMETER

of High Sensitivity and Stability for

QUANTITATIVE PAPER CHROMATOGRAPHY

combines the Welch **DENSICHRON** ®

with Transmission Light Source



No. 3835B Patent No. 2424953

The special Welch Transmission light source with a filter paper guide for holding and advancing the papergram at 3 mm increments, when used with the Densichron becomes a complete transmission densitometer for quantitative paper chromatography. The quantitative analysis of complex compounds such as PROTEINS, SUGARS, VITAMINS, etc., has been simplified by reading maximum densities of papergrams with the DENSICHRON.

This new apparatus and procedure will speed up your work and permit the analysis of very small samples. Works equally well for quantitative paper electrophoresis.

This instrument was demonstrated last December at the Chemical Industries Exposition in Philadelphia.

Write for literature describing the production of papergrams and the use of the Densichron for quantitative determination by the maximum density method.

No. 3835B **Complete $425.00**

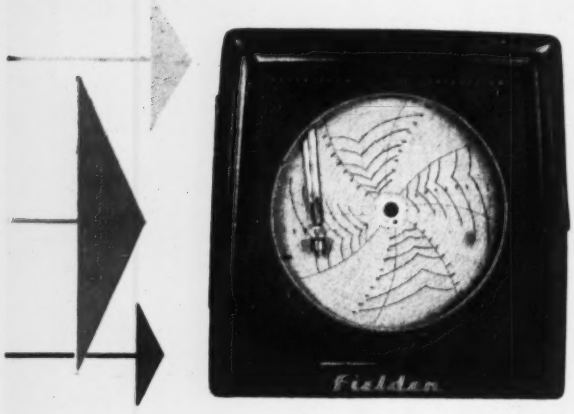
Write for Circular

Manufacturers of Scientific Instruments and Laboratory Apparatus

W. M. WELCH SCIENTIFIC COMPANY
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
ESTABLISHED 1880
1515 Sedgwick St., Dept. E, Chicago 10, Illinois, U.S.A.

For more information circle **44** on inquiry card.

must a well engineered chart recorder be expensive?



fielden says, "no!" when you can install a MULTIPOINT Recorder with up to 48 or 96 separate points—with each point available at a cost unheard of before!

Reason: Simplified design, circuitry, and construction. The chart mechanism is rugged, but so simple in form that there is little or no maintenance throughout the life of the instrument. Yet it's *accurate*—to ±½% of full scale, with a sensitivity of 0.1% and reproducibility of ±0.5%. Fielden furnishes 3 types of Multipoint Recorders: TEKTOLOG electrical quantity for pH, thermocouple and tachometry; A.C. NULL BALANCER for resistance temperature and conductivity measurements; and D.C. NULL BALANCER.

Does simplified, low cost—and reliable instrumentation appeal to you? Then use the coupon below today for full details.

Robertshaw-Fulton
CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
2920 N. 4th St., Dept. A, Philadelphia 33, Pa.
Send full details on the Fielden Multipoint Recorders checked below.
☐ TEKTOLOG Electronic Recorders ☐ A.C. NULL BALANCE Recorders
☐ D.C. NULL BALANCE Recorders

Name_____
Title_____
Company_____
Address_____ City_____ State_____

For more information circle **45** on inquiry card.

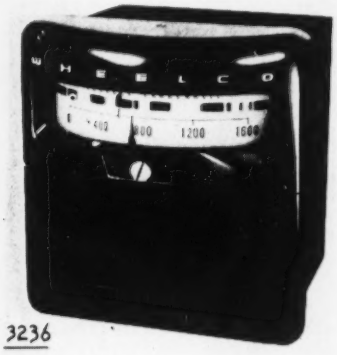
NEW INSTRUMENTS

250 v.ac.; ¾ hp. at 115 v.ac.; 1½ hp. at 230 v.ac. No adapter plates required for installation; units mounts directly on a standard 2x3 in. switch box with two screws.—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box* 400, *Knoxville, Tenn.*

For more information circle **208** on inquiry card.

Limit Controller

New "700 Series Limitrol," companion electronic limit controller for "400 Series Capacitrol," shuts off fuel supply at temperature manually set and, if desired, sounds an alarm.

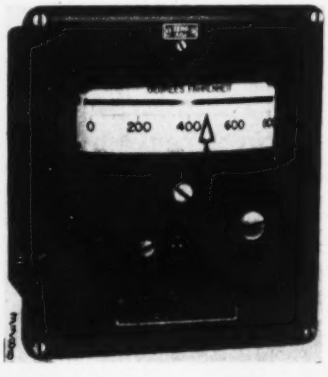


Thermocouple break protection feature shuts off fuel in event of TC failure or broken TC connections.—*Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.*

For more information circle **209** on inquiry card.

Temperature Controller

New "Model 292 Series Capacitrol" features ease of servicing, uses plug-in temperature measuring system and control chassis; provides for flexible

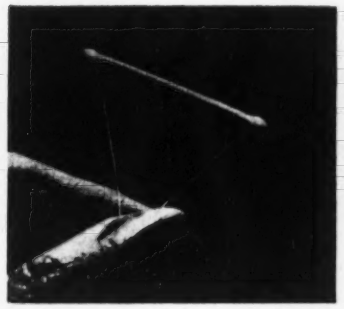


"on-the-job" adjustment for tuning alignment index and indicating pointer, and adjustment of anticipatory action cycle time (on "Model 292C"). Thermocouple break protection (shuts off fuel supply in case of TC or lead wire failure) can be supplied as an extra.—*Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.*

For more information circle **210** on inquiry card.

Radiosonde Thermistor

New thermistor designed specifically for temperature measurement and control in range of –60 C. to 40 C. is made of metal oxides and manufac-

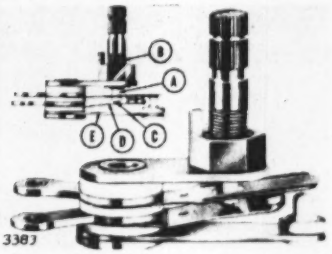


tured by a ceramic process. All units are waterproofed and coated with reflective coating.—*Ferroxcube Corp. of America, 43 E. Bridge Street, Saugerties, N Y.*

For more information circle **211** on inquiry card.

Thermostats

New "Type S" and snap-acting "Type SA" bimetal thermostats have been redesigned to incorporate pin type construction claimed to give "virtually linear operation over thousands

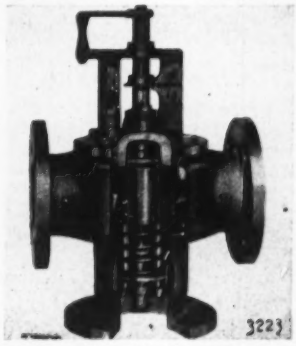


of cycles." Steatite pin A, inserted in lower end of adjusting stem B, carries hardened steel pin C which applies adjustment pressure against contact spring member D. New design eliminates whip and wear of adjusting pin which makes thermostat calibration climb.—*Stevens Mfg. Co., Inc., Mansfield, Ohio.*

For more information circle **212** on inquiry card.

Self-operated Temperature Regulators

New "Nos. 1280 and 1281" temperature regulators for use on internal combustion engines and other temper-



ature control applications are supplied with three-way valves; contain from one to four "Power-Pill" units, depending upon size of valves, which are available in sizes ranging from 2-in. to 6-in. Temperature settings are available in range from 120 F. to 190 F. in 10 to 15-deg. increments; may be altered by changing "Power-

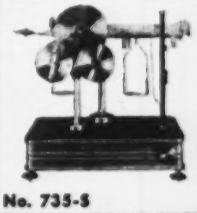
QUALITY CONTROL
with
CHATILLON TORQUE TESTERS

a complete line of precision torque testers from 1/10 gram centimeter to 10,000 foot lbs. capacity

Model 935 Torsion Tester.
To measure or apply clockwise or counterclockwise torsion from 1 inch ounce or 50 gram centimeters to 5 inch pounds or 5,000 gram centimeters.

A century of experience and "know-how" in the manufacture of fine torque testing instruments makes Chatillon your first choice for quality control equipment.

Chatillon torque testers—in a wide range of models and capacities—are the best answer to most torque measuring problems. Precisely engineered and designed . . . ruggedly built, they have become the industrial standard for quality control and production torque measurements in hundreds of applications. These include: torque wrench and screwdriver testing . . . starting and stalling torque of motors . . . low rpm applications . . . torque drive testing for small assemblies. (Standard testers adaptable for special test purposes.)



No. 735-S TORSION SPRING TESTER

No. 942 TORSION SPRING TESTER

For the fast, economical solution to your special problem, consult Chatillon's Engineering Department. *Write for FREE illustrated Torque Tester Bulletin No. 45.*

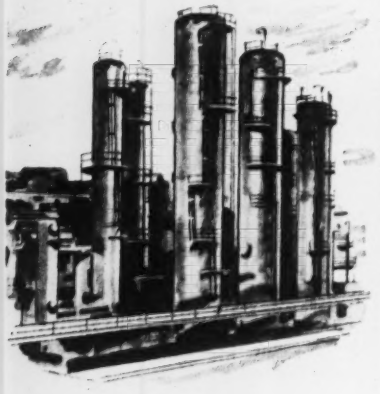
JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N. Y.
Manufacturers of Precision Springs and Measuring Apparatus Since 1826

For more information circle **46** on inquiry card.

DE LUXE MODEL

$49,000,000.00

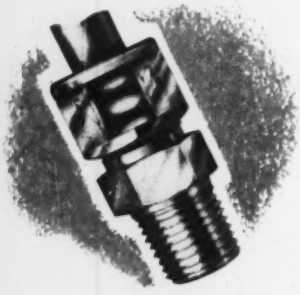
LEAK DETECTOR



While this leak-detecting device carries a $49,000,000.00 price tag, it is worth every penny of it! This device will not find leaks any faster than lower-priced models, but it will usually find more of them.

Leaks are expensive. Why not specify Swagelok Fittings and stop leaks before they happen?

Write for the Swagelok Catalog today. Address Department 12



Swagelok®

TUBE FITTINGS

BRASS • ALUMINUM • STEEL

STAINLESS STEEL • MONEL

CRAWFORD FITTING CO.

884 E. 140th Street

Cleveland 10, Ohio

For more information circle **47** on inquiry card.

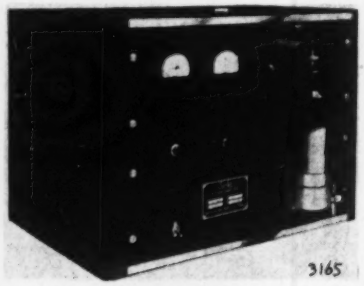
NEW INSTRUMENTS

Pill" units. "No. 1280" is equipped with a quick-acting manual operator which can be used to override thermal element for special situations.—*Fulton Sulphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.*

For more information circle **213** on inquiry card.

Dewpoint Hygrometer

New "No. 900-1" measures dewpoint temperature between 18 C. and minus 50 C. within 1 C., with continuous-sample flow-rates between 500



and 2,000 cc/min. and pressures between 0.5 and 1.5 atmospheres. Photoeclectric system continuously "observes" a minute mirror on which dew is formed and automatically holds this mirror at dewpoint temperature. A fine-wire thermocouple integrated with mirror permits indicated or recorded results.—*Burton Mfg. Co., 11201 W. Pico Blvd., Los Angeles 64, Calif.*

For more information circle **214** on inquiry card.

Sealed Thermostat

New "C8 Series" thermostats meet electronic and aircraft requirements; are suitable for direct control of heaters and for temperature alarm or cut-

off service; are adjustable either at factory or by user; can be set to operate at any temperature down to minus 100 F. or up to 300 F. Response is rapid because encasing shell is temperature-responsive element. Repetitive operation is within 1 F.; differential is about 1 F.; contact rating is 5 amps. at 115 v.ac.—*G-V Controls Inc., 28 Hollywood Plaza, East Orange, N. J.*

For more information circle **215** on inquiry card.

Hand Pyrometer

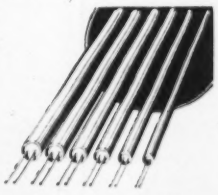
New illuminated dial feature, extra in "Xactemp Hand Pyrometers," per-

mits reading pyrometer in poorly lighted areas; uses two easily-replaced "penlite" cells.—*Claud S. Gordon Company, 8000 S. Wallace St., Chicago 16, Ill.*

For more information circle **216** on inquiry card.

TC-wire Insulation

New 2000 F. thermocouple wire insulation comprises TC wires surrounded and insulated by pure magnesia; assembly inserted and swaged into a metal sheath. Available in



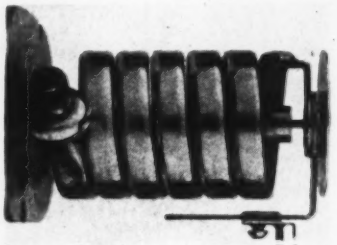
Chromel-Alumel, iron-Constantan and platinum-platinum rhodium, with Inconel, stainless steel, aluminum, copper and other sheath materials; OD from 0.04 in. to 0.32 in. with two wires. Material makes gas-tight TCs; can be sharply bent; mounting flanges can be welded to sheath without destroying insulation.—*Aero Research Instrument Co., 1901 N. Hermitage Ave., Chicago 22, Ill.*

For more information circle **217** on inquiry card.

PRESSURE and VACUUM

Pressure Elements

New line of pressure-measuring elements features greater operating power and improved accuracy; wide choice

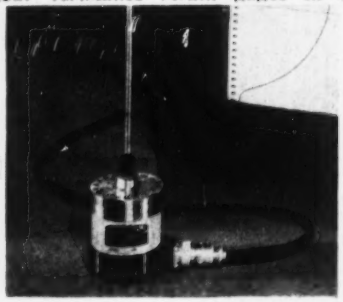


of materials such as corrosion-resistant Type 316 stainless steel, beryllium copper, and "Ni-Span" notably unaffected by ambient temperatures. Designs include helical for pressures to 80,000 psi.; also diaphragm, bellows, spiral and standard helical covering ranges from 10 in. water to 6000 psi. —*The Foxboro Co., Foxboro, Mass.*

For more information circle **218** on inquiry card.

Pressure Pickup

New "Teledyne Bonded Strain Gage Pressure Transmitter" comprises a corrosion-resistant stainless steel diaphragm which deflects a metal ring elastic member to which are bonded four resistance strain gages in a

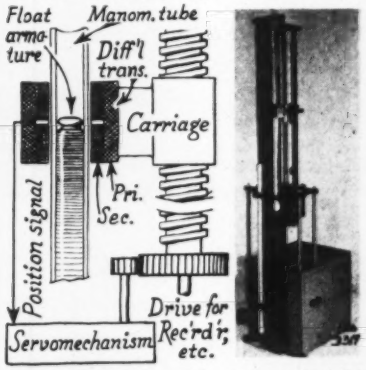


bridge circuit: two bonded to internal surface and two bonded to external surface of ring; circuit fully compensated for temperature variations. Natural frequency exceeds 2000 cps. Insensitive to accelerations in two horizontal planes and vertically less than 0.3 percent of full-scale per *G*. Ranges to 1000 psi. Stainless steel pressure chamber and acid-resistant seals resist corrosive gases and fluids including fuming nitric acid.—*Section 75, Taber Instrument Corp., 111 N. Goundry St., North Tonawanda, N. Y.*

For more information circle **219** on inquiry card.

Manometer Follower

New "Exactel" manometer follower comprises a precision-bore manometer to suit user, and a servo system whereby top of liquid column is continuously followed by a specially designed induc-



tive pickup. Alternating magnetic field produces microinch vibrations of float armature, doing away with shortcomings of conventional floats. Sensitivity is 0.0001 in. or better; accuracy depends mainly on manometer-tube uniformity and lead screw linearity; instrument as made is said to be "perhaps the most accurate device commercially available for pressure measurement within the range of liquid manometers." Systems are available for absolute, gage and differential pressure. Photo shows a 60-in. absolute pressure system.—*Fanger Research Lab., Los Gatos, Calif.*

For more information circle **220** on inquiry card.

Pressure Switches

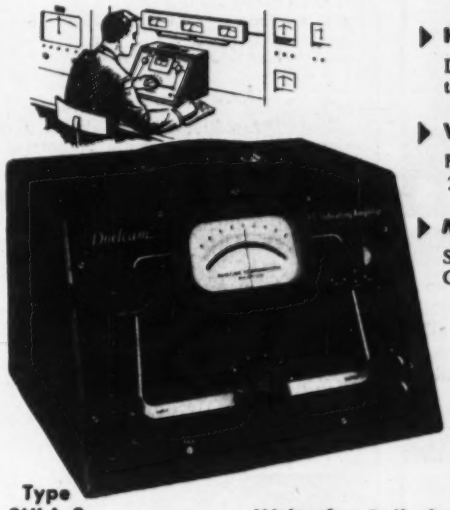
New "Series DAW Weather-resistant Pressure Controls" are so constructed as to exclude a beating rain, conform to NEMA specifications. Case is flanged and has a ¼-in. pipe connec-

a UNIQUE application . . . of a NEW principle

for a BETTER instrument

Doelcam

D-C Indicating Amplifier



- **High Stability** — Less than 10 microvolts long term drift
- **Wide Dynamic Response** — Flat from 0 to greater than 20 cps
- **Magnetic Input** — Second-Harmonic Magnetic Converter for input stage

Linearity within 1%

High input impedance

Zero-center meter

Will drive recorders

Type 2HLA-3

Write for Bulletin IA-4

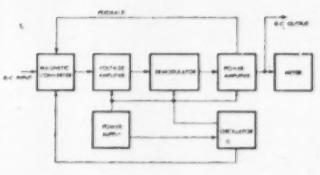
THE DOELCAM D-C Indicating Amplifier is a completely self-contained instrument for the amplification and measurement of d-c voltages and currents of minute magnitude. A new design concept employing the remarkable sensitivity and inherent stability of the second harmonic magnetic converter is used in the input stage of the amplifier. This design feature, by eliminating all moving parts such as mechanical choppers, makes this instrument ideally suited for applications where accuracy, reliability and insensitivity to changing ambient conditions are of prime importance.

Doelcam CORPORATION

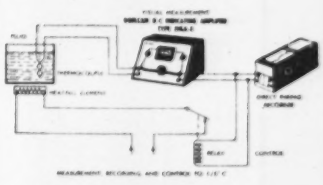
SOLDIERS FIELD ROAD, BOSTON 35, MASS.
West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

Instruments for Measurement and Control

Synchros • Gyros • Servos • Microsyns • Servo Motors



MAGNETIC INPUT . . . Block Diagram showing DOELCAM Second Harmonic Magnetic Converter as input stage . . . a new design concept

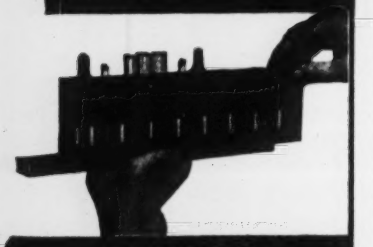


MEASUREMENT - RECORDING - CONTROL to 1/5° C. f. typical Process Control application showing high accuracy of DOELCAM Type 2HLA-3

For more information circle **48** on inquiry card.

Want the easiest way to make fast, accurate

pH, CHLORINE TESTS?



TAYLOR COMPARATORS

EASIEST...

because three simple steps give you the determination; every Taylor set is supplied with all necessary reagents and accessories. And, Taylor sets are lightweight, yet strongly built.

EASY...

because many tests can be made in only a few seconds. Others take no longer than a few minutes. Taylor sets are compact, portable so you can make tests on-the-spot, no time wasted carrying samples back to the lab.

ACCURATE...

because all Taylor liquid color standards carry an unlimited guarantee against fading.

All standards for any one determination are housed in a single plastic slide. No single standards to handle. Many different slides can be used on one base.

See Your Dealer Soon!

FREE MANUAL

"Modern pH and Chlorine Control" illustrates and describes full Taylor line. Also gives useful data on theory and application of pH and Chlorine control. Write today.

W. A. TAYLOR AND CO.
416 RODGERS FORGE RD • BALTIMORE MD

For more information circle **49** on inquiry card.

NEW INSTRUMENTS

tion; finish will withstand 50-hour salt spray test. Cover is neoprene-gasketed to case and is vented to drain condensation. Units are available in 17 operating ranges from 30 in- vac. to 300-2500 psi. with sensitivities from 2 oz. to 20 psi. depending upon range.—*The Mercoid Corp.*, 4201 *Belmont, Chicago* 41, *Ill.*

For more information circle **221** on inquiry card.

Vacuum Gage

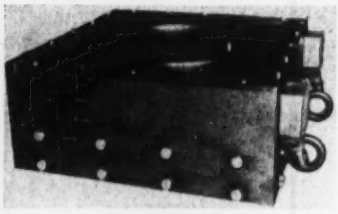
New "Asco" thermocouple-type vacuum gage is extremely sensitive in 30-to-0-micron range; is not damaged by exposure to atmospheric pressure; requires no adjustment or attention from operator. Range: 500 to 0 microns. Is calibrated for dry air.—*Bronwill Scientific, Inc.*, 45 *Russell St., Rochester* 7, *N. Y.*

For more information circle **222** on inquiry card.

FORCE, LOAD

Load Gage

New "Pressductor" has been developed for "non-electronic industrial



pressure measurement, e.g. on rolling mills."—*Asea, Vasteras, Sweden.*

For more information circle **223** on inquiry card.

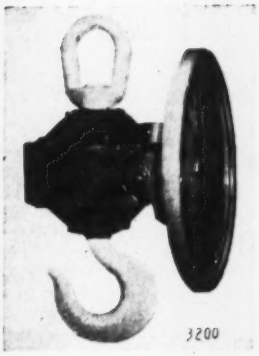
Load Cells

Five new low-capacity "SR-4" load cells extend capacity range of maker's standard load cells down to 0-50 lb. Three "Type U-1" cells, for either tension or compression loads, have capacities of 0-50, 0-100, and 0-200 lb. Two "Type T-1" cells, for tension only, have ranges of 0-100 and 0-200 lb. Cells operate on either a.c. or d.c. at 4 to 8 volts; input resistance 120 ohms; calibrated accuracy is within 0.25 percent of full range.—*Baldwin-Lima-Hamilton Corp. Philadelphia* 42, *Pa.*

For more information circle **224** on inquiry card.

Hook Scale

New "SU-20 Sensater" is a hydraulically-operated hook scale with guaranteed accuracy of 0.25 percent of capacity at any point on dial, made possible by use of a mobile diaphragm that develops a piston-like stroke without friction. Diaphragm does not deflect, but moves with its backing plate. "Sensater" is available in three capacities: 5,000, 10,000 and 20,000 lbs.



Twelve-inch dual-range dial can be tilted up or down to any eye level. High safety factor: ultimate strength more than five times rated capacity.—*Martin-Decker Corp.*, 3431 *Cherry Ave., Long Beach* 7, *Calif.*

For more information circle **225** on inquiry card.

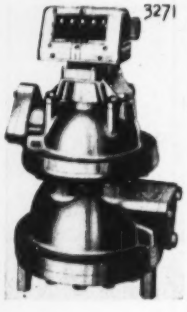
Scale for Weighing Trucks in Motion

New "TR-1" electrical highway scale records both single and dual axle truck weights in motion. Since drivers will not know when or where this weighing takes place, equipment is particularly useful for highway research and for maximum-load regulations enforcement. Highway part of unit consists of a level platform in traffic lane, just wide enough (3x10 ft.) to catch each wheel of axle, supported by electrical load cells. At normal highway speeds an axle will be on this platform for 1/30 second.—*Neptune Meter Co.*, 50 *W. 50th St., New York* 20, *N. Y.*

For more information circle **226** on inquiry card.

FLOW and VOLUME

High-pressure Positive-displacement Meters

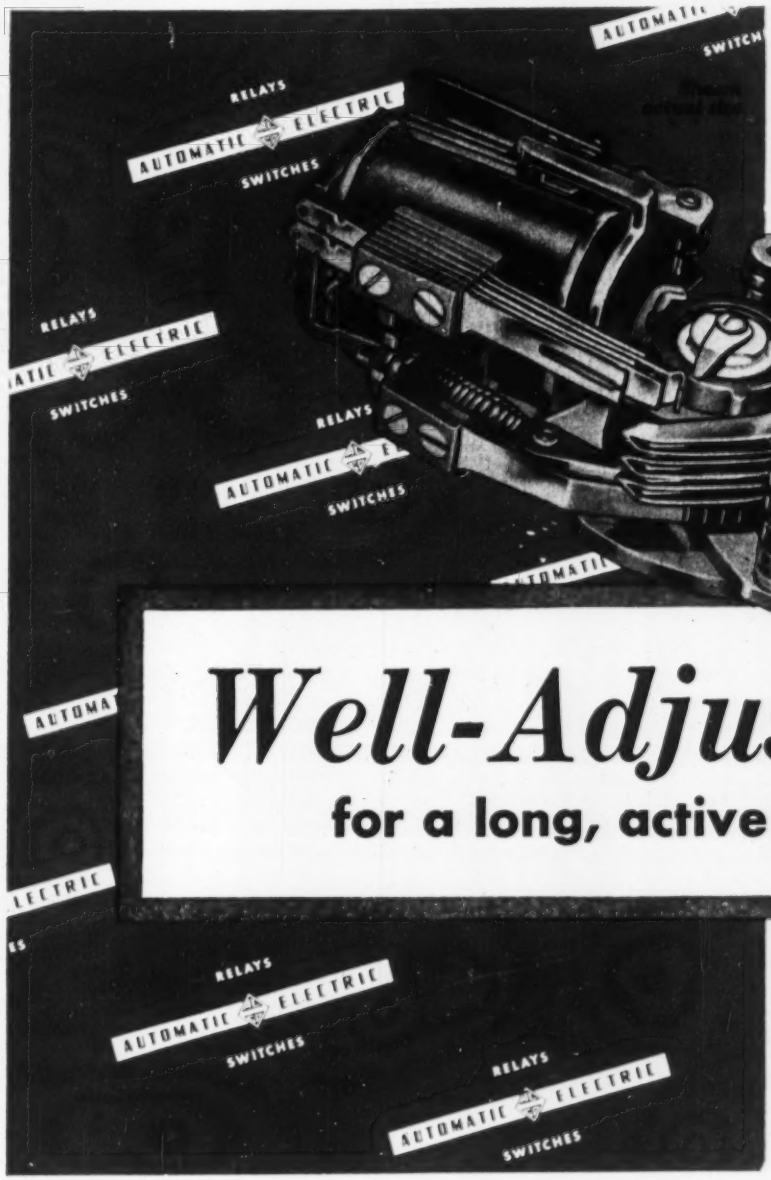


Two new "Xacto" meters are announced: "Fig. 470-15-4" is rated at 15 gpm., 500 psi., has 1½-in. flange connections; "Fig. 470-50-4" is rated at 50 gpm., 500 psi., has 1¼-in. screwed connections. Working parts of both new meters are stainless steel, hard carbon bearings and Teflon pistons. Both may be equipped with straight-reading, totalizing or ticket-printing dials. Both are designed for either top or bottom mounting.—*Bowser, Inc.*, 1300 *Creighton Ave., Fort Wayne* 2, *Ind.*

For more information circle **227** on inquiry card.

Chemical Pumps

New "Chempump" is a totally-enclosed "canned rotor" pump said to be the first seal-less leakproof unit available to general industry. Combining motor and pump, it eliminates mechanical seals, stuffing boxes and packing glands. Pumped fluid is designedly allowed to enter rotor cham-



TYPE 44
MINIATURE STEPPING SWITCH
featuring: small size, indirect drive, and one-coil design.

Well-Adjusted

for a long, active life

200,000,000 operations, with little or no adjustment!

This rugged little stepping switch is racking up an outstanding service record in countless operations. It's Automatic Electric's Type 44 Miniature Stepping Switch, now going into more products than ever before!

Its cost-reducing features are impressive. One-coil design eliminates a separate release coil. Indirect drive gives smooth, high-speed stepping. There's no wiper "double loading" or galloping. Here's the first compact, lightweight switch for 10-, 20- or 30-point operations. Use any dc voltage up to 110 (with rectifier, up to 115 volts, 60 cycles, ac).

To improve your products without raising costs, get the full details on Type 44 and Automatic Electric's *complete* line of stepping switches. Write to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.

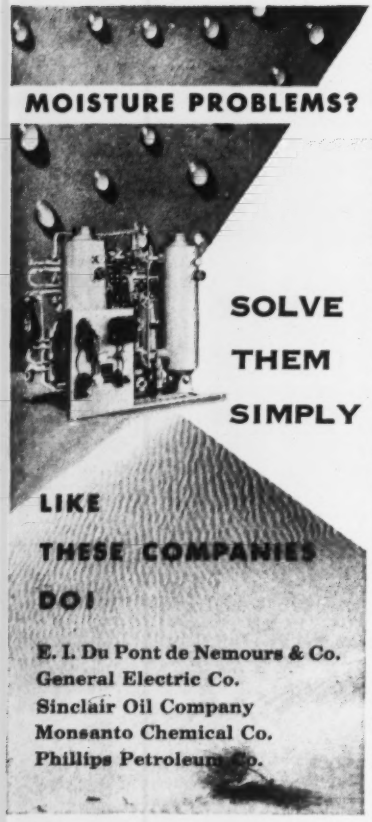
RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

For more information circle 50 on inquiry card.



. . . and dozens and dozens more of the country's leading firms, technological schools, the armed services, the U. S. Atomic Energy Commission . . . *all* choose Pritchard HYDRYERS* for efficient, dependable dehydration of compressed air and other gases for instrument and process controls.

Standard packaged units reduce dew points to minus 40°F...custom units for extreme conditions or special requirements.

For complete information, request HYDRYER bulletin 16.0.081.

*Registered Trade Name

Industry's Partner for Progress

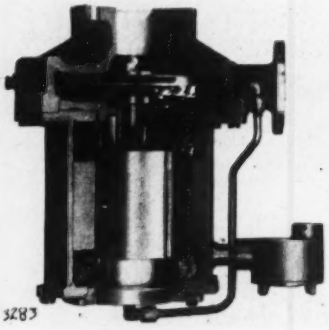
J.F. Pritchard Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 345, 210 West 10th Street
Kansas City 5, Mo.

Representatives in Principal Cities From Coast to Coast

COOLING TOWERS • SPECIALIZED HEAT EXCHANGERS • GAS & AIR TREATING EQUIPMENT

For more information circle **51** on inquiry card.

NEW INSTRUMENTS

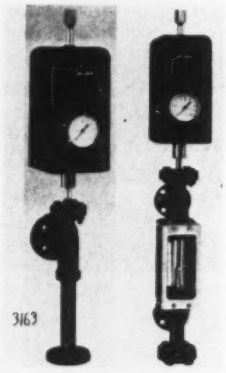


ber. A stainless steel liner, inserted in air gap of motor, isolates stator section. Capacities up to 180 gpm. at heads up to 90 ft. Standard models can handle fluids at temperatures to 450 F. and pressures to 150 psi.; simple modifications permit 600 F. and 5000 psi.; special models handle greater extremes. Fluids range from butyl acetate to titanium tetrachloride, including hot sulfite liquors, hydrocyanic acid, molten sulfur and many other hard-to-handle fluids.—*Chempump Corp., Station A,* 1300 *East Mermaid Lane, Philadelphia* 18, *Pa.*

For more information circle **228** on inquiry card.

Rotameter Transmitters

New "Mag/Nu/Matic" force-balance rotameter float-position transmitters are available in "Armet" all-metal

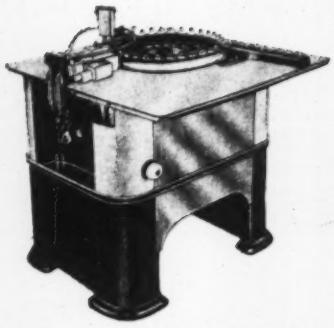


model (left) and "Full-View" with safety shielding (right), for use with all types of pneumatic receivers and control instruments. Among features: only three moving parts; full-range linearity; exceptionally rapid response.—*Brooks Rotameter Co., Lansdale, Penna.*

For more information circle **229** on inquiry card.

Vial Filler

New "Vialfil Model RF-2" fills 1-cc. to 30-cc. containers at speeds of up to 3600 per hour; will handle oils, solutions, suspensions. Sterile filling of vials and small bottles, two at a time, is performed with accuracy: filler may be located under a sterile hood and used in conjunction with a "PerfeKtum Vial Stoppering Machine." Unique design facilitates vol-



umetric adjustment, changeover and sterilization.—*Popper & Sons, Inc., 300 4th Ave., New York, N. Y.*

For more information circle **230** on inquiry card.

LEVEL

Level Controller

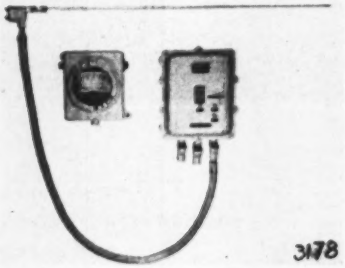
New "Prob-A-Larm" uses bridge circuit to give extreme dependability in capacitance relay circuit. No coax cable is required. Probe may be lo-

cated as far as 500 ft. from main unit. Instrument works with almost any liquid, powder, or material in chunks; gives electrical signal when material reaches probe in vessel.—*Jarco Services Inc., 725 South Erie, Tulsa 12, Okla.*

For more information circle **231** on inquiry card.

Level Indicator

New "Telstor" level indicators in explosion-proof cases are available to meet requirements of NEC Article

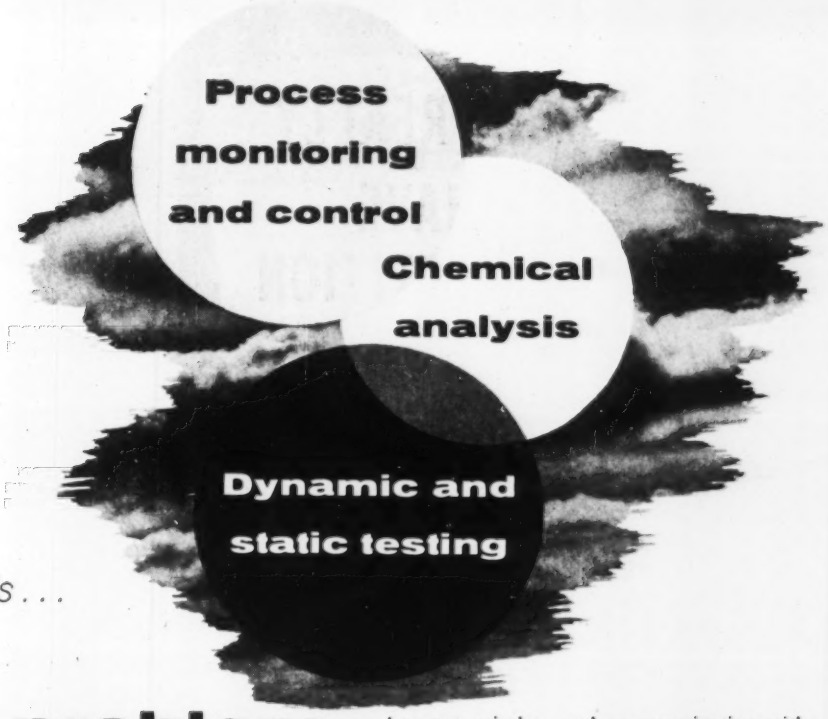


500, Class I, Group C and Group D; Class II, Groups E, F and G; in several combinations suitable for industrial and laboratory applications.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.*

For more information circle **232** on inquiry card.

Level Indicator

New "Belmont" level indicator utilizes a capacitive-type probe with no floating or moving parts nor contact-making electrodes; is suitable for use with most non-adhesive chemicals, milk, oils, refrigerants and all condensed gases; is operable over a temperature range of 500 to –425 F. and



In these fields . . .

your problem is our starting point

An open mind . . . and an organization with 17 years' practical experience in control and information handling are the Consolidated Systems Division's most valuable assets. Together, they make it possible for the Division to do not only a *complete* job — engineering, fabrication, installation, instruction, service — but the most practical one from the standpoints of both efficient operation and dollar value.

Complete professional freedom to select those components that will do the particular job best and at the lowest cost means that the buyer is assured of the optimum solution to his problem. Components may be standard Consolidated Engineering products, units specially engineered for the project, or items purchased from other manufacturers . . . the sole criterion is that they solve *your* automatic control, testing and analytical problems.

The story of the Systems Division . . . and examples of the work they have done . . . are told in a new brochure, available on request. Write for Bulletin CEC 1304-X3.

Systems Division CEC

Consolidated Engineering Corporation

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.**, *a subsidiary with offices in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, Seattle, Washington, D. C.*

For more information circle **52** on inquiry card.

YOU REALLY HAVE COMPETITION NOW

AUTOMATIC TIMING

WILL
- SAVE TIME
- REDUCE REJECTS
- INCREASE PRODUCTION

If you manufacture a product, quality timing or counting will control your processes with less wasted time . . . with increased precision . . . and will speed up production. The element of human error, increased with fatigue, often is responsible for trouble-making rejects. Eagle engineers will build a timer to answer your production problems. Send your problem today.

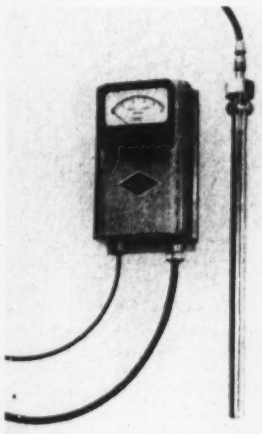
Write for FREE AUTOMATION BOOKLET "See What Timing Can Do For You"

EAGLE SIGNAL CORPORATION MOLINE, ILL.

Industrial Timers by EAGLE

Eagle Timers save time, save money.

For more information circle **53** on inquiry card.



from high vacuum to 100,000 psi. Coaxial cable can, if necessary, be as long as 1,000 feet.—*Thermo Instruments Co.*, 1310 *County Rd., Belmont, Calif.*

For more information circle **233** on inquiry card.

DISPLACEMENT

Displacement Pickups

New "Extensometer Micrometers" are available in ranges from 0.05 in. to 200 in.; measure motion, position and vibration, for automatic inspection of parts, comparative tracking of two motions, to operate servomechanisms such as profilers, etc., or to supply data to computers. Some models can be used in corrosive liquids and gases. Resolution of all models 0.000,000,01 in.; sensitivities to 40 v./in.; linearities to 0.05 percent of linear range; no force required for displacement of probe. Principle: unique configuration of variable-permeance bridge.—*Crescent Engineering & Research Co.*, 14828 *Arrow Highway, Baldwin Park, Calif.*

For more information circle **234** on inquiry card.

Displacement Pickup

New "Model 154 Linear Motion Transducer" is free from changes in scale factor with variations in frequency, excitation voltage and temperature over wide ranges; can serve as gage, monitor and control-system sensor. Available in a military package for use in pressure and acceleration pickups. Operates from excitation voltages of 28 to 115 v. 60 to 600 cps. Output voltage is linear with armature displacement from 0 to 0.12 in. with 0.25 percent accuracy and up to 0.25

in. with 0.5 percent accuracy; output symmetrical about a null position or can be in one direction—*General Cybernetics Associates, P. O. Box* 987, *Beverly Hills, Calif.*

For more information circle **235** on inquiry card.

TIME

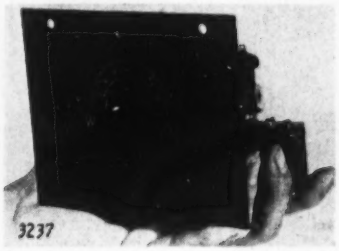
Process Timer

New "TSA-21" process timer has time scale calibrated from 0 to 100 percent. It controls timed simultaneous closing of one electric circuit and opening of another. "TSA-21" includes one set of time-opening main contacts and one set of electrically separate time-closing main contacts; also a set of instantaneous contacts which can be used independently or as hold contacts for timer solenoid.—*Instrument Dep't, General Electric Co., West Lynn* 3, *Mass.*

For more information circle **236** on inquiry card.

Automatic Timer

New "Type 12 MC" low-cost electronic interval timer is suitable for push-button, foot-switch or other actuation of controlled-interval spot welders, etc.; utilizes two cold-cathode

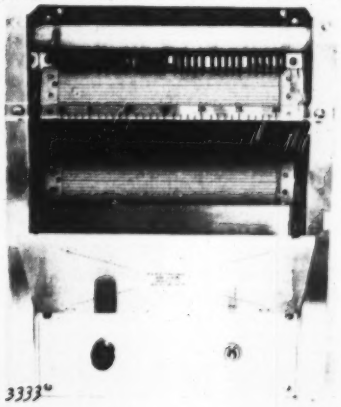


tubes (no warmup time) for intervals from 0.05 to 7 seconds. Duration of interval is continuously adjustable. S-p.d-t electromagnetic relay has normally-open 10 amp contacts.—*G. C. Wilson & Co.*, 1950 *Eighth Ave., Huntington, W. Va.*

For more information circle **237** on inquiry card.

Multistylus Recorder

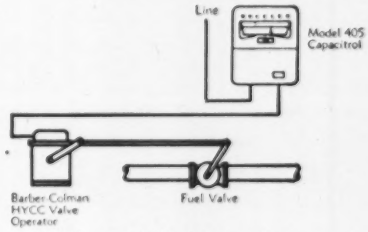
New "Model ROS" multichannel strip-chart recorder records time, sequence and duration of as many as 30 machines. No ink, type-ribbon or moving pens: stylus makes trace on elec-



BARBER COLMAN

NEW Wheelco Model 405 Capacitrol

Offers simpler low-cost proportioning control



Capacitrol Controlling Fuel Fired Furnace or Oven

There's no other Controller like it! The new ultra-sensitive Model 405 Wheelco Capacitrol is completely self-contained and utterly flexible. Offers a simplified, entirely nonmechanical system for maintaining true proportional relationship between fuel input and a continuously measured temperature. Feeds output of electronic circuit into a polarized relay, which serves as the control valve actuator. This exclusive Wheelco development makes possible faster, more accurate control for continuous process applications. Provides convenient manual "droop" correction and proportioning band adjustment. Automatically shuts off fuel input in event of thermocouple failure or broken connection. On-the-job system changes simplified by interchangeable control chassis. Low in cost. Offers many new design features. Write for Bulletin F-6493.

WHEELCO INSTRUMENTS DIVISION

BARBER-COLMAN COMPANY, DEPT. K, 1515 ROCK ST., ROCKFORD, ILLINOIS

BARBER-COLMAN OF CANADA, LTD. • TORONTO, ONTARIO, CANADA

Industrial Instruments • Automatic Controls • Air Distribution Products • Aircraft Controls • Small Motors
Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **54** on inquiry card.

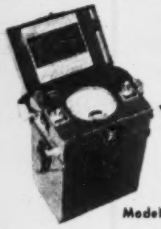
INSTRUMENT
DAVIS
DIVISION

PORTABLE
AND CONTINUOUS

GAS ANALYSIS
SYSTEMS

by

√ Catalytic Combustion
√ Electro-Conductivity
√ Thermal Conductivity
√ Photochemical Reactions



PORTABLE
COMBUSTIBLE
GAS DETECTOR

Quick, dependable on-the-job analysis.

Model M-1

Send for Bulletin 1147.

SEMI-PORTABLE
ELECTRO-
CONDUCTIVITY
GAS ANALYZER

Accurate on-the-spot analysis of SO_2, H_2S, chlorinated hydrocarbons, nitrous fumes, etc. in toxic ranges.

Send for Bulletin 11-70.

PHOTO-
CHEMICAL
OXYGEN
ANALYZER

Continuous measurement of oxygen in gaseous streams, 0-100 p.p.m.

Send for Bulletin 11-40.

Progressive Manufacturers
of Gas Analysis Instruments.

DAVIS EMERGENCY EQUIPMENT CO., INC.
80 Halleck St., Newark 4, N. J.

For more information circle **55** on inquiry card.

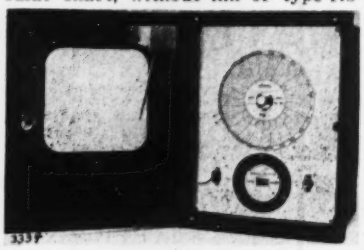
NEW INSTRUMENTS

trosensitive paper only when current flows; no drying, developing or other processing. Paper does not deteriorate with age, takes pen or pencil notes. Various chart speeds available.—*Larson Instrument Co., 24 Orchard St., Tarrytown, N. Y.*

For more information circle **238** on inquiry card.

Operation-time Recorder

New "Model RO" records time, sequence and duration of a process or manufacturing operation, on a circular chart, without ink or type-ribbon. Specially treated chart requires no drying, developing or other processing, does not deteriorate with age, takes pen or pencil notes. Recording arm mounted on door prevents interference when changing charts. Quick and easy replacement of plug-in writing system. Various chart speeds. ★"Model ROT" is similar but has a cumulative time meter for running time or idle time.—*Larson Instrument Co., 24 Orchard St., Tarrytown, N. Y.*

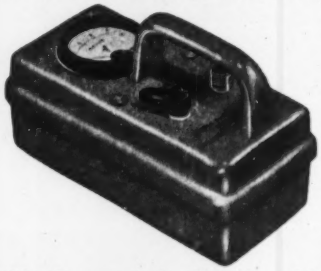


For more information circle **239** on inquiry card.

NUCLEONICS

Gamma-dose Ratemeter

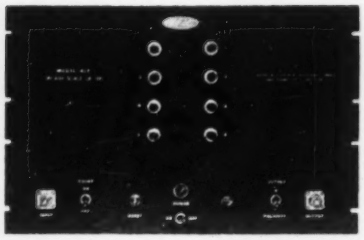
New "Model 592" measures intensity of x and gamma rays; features: (1) interchangeable ion chambers located at bottom; (2) positive zeroing within 2 percent in 500-r/hr. field; (3) wave-length independence throughout broad range; (4) zero drift approx. 1 percent in 8 hr. and is always upscale during battery aging; (5) saturation of ion chamber on all ranges; (6) each instrument factory-calibrated on x-rays, radium or cobalt-60.—*The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*



For more information circle **240** on inquiry card.

10-Mc. Decade Scaler

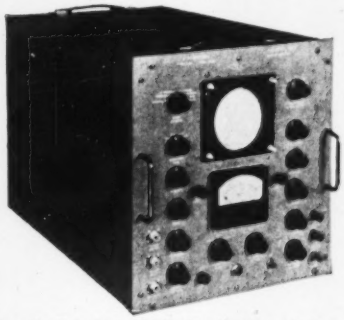
New "Model 412 Fast Decade Scaler" is for precise high-speed counting of fast pulses, and small time-interval measurements (to 0.1 usec. accuracy). Scale factor of 100 and output pulse characteristics have been chosen so that almost all conventional commercial scalers (approx. 10^5 counts/sec.) and frequency counting equipment, can be operated from output pulse with ease.—*Electrical & Physical Instrument Corp., 25 W. 43d St., New York 36, N. Y.*



For more information circle **241** on inquiry card.

Synchroscope

New "Model C-04" is said to represent the first significant redesign of basic "P-5" synchroscope originally developed by MIT Radiation Lab.—*T.L.G. Electric Corp., 31 W. 27th St., New York 1, N. Y.*



For more information circle **242** on inquiry card.

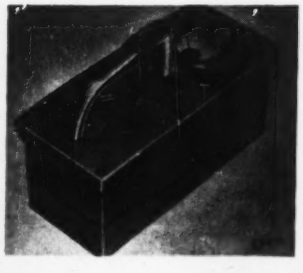
Alpha Scintillation Counter

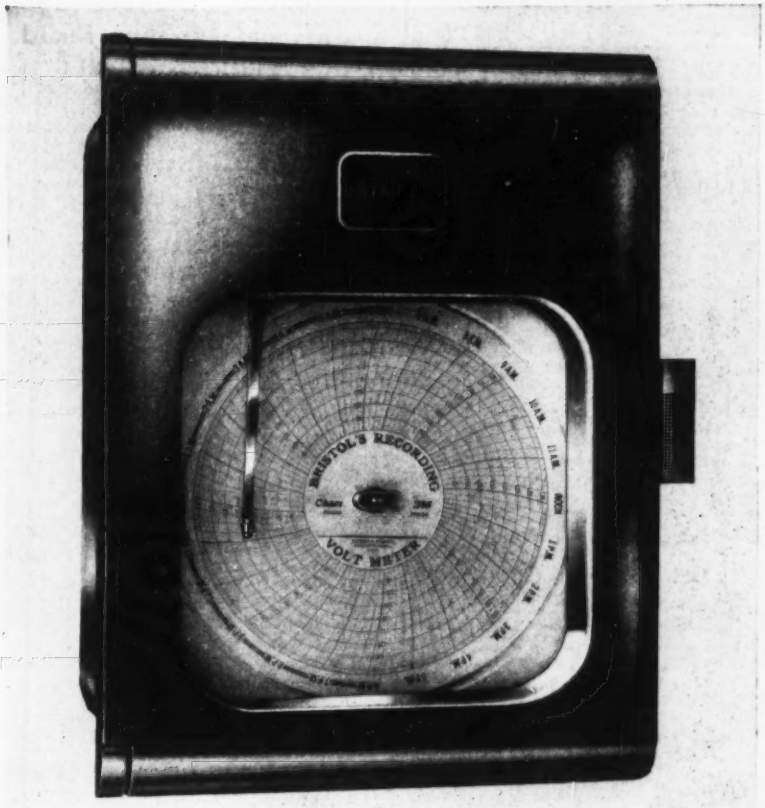
New "Model DP1," ready for connecting directly to any commercial scaler, contains a 6292 photomultiplier, preamplifier, a zinc-sulfide phosphor, and a light-proof housing containing a Lucite sample and absorber holder. Several shelf-spacings are provided for positioning sample with respect to phosphor.—*Detectolab, Inc., 6544 Sheridan Rd., Chicago 26, Ill.*

For more information circle **243** on inquiry card.

Neutron Monitor

New "Model 2715 Nemo" battery-operated survey meter measures thermal and fast neutrons separately; range 10 to 10^4 neutrons/cm^2/sec.; contains two enriched BF_3 neutron





NEW, EASY-TO-READ BRISTOL RECORDING VOLTMETERS AND AMMETERS are available for permanent mounting or for use as portable instruments.

You'll get greater accuracy, greater dependability with Bristol recording voltmeters and ammeters

Here's why:

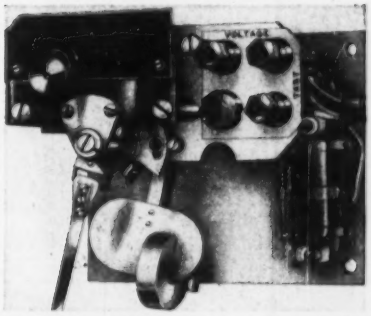
1. Low electrical burden — the lowest burden of any round-chart recorder on the market.
2. Extremely high torque gradient.
3. Temperature compensation.
4. Shock-proof measuring mechanism mounting.
5. Leveling of instrument not critical.
6. Continuously legible recording of sudden changes — up to full scale value.

These modern units are designed for easy use, with dust- and moisture-proof die-cast aluminum case; quick-set chart hub for easy chart changing; non-obscuring pen lifter; and snap-on chart plate.

Get the whole story on these precision instruments. Write today for free 28-page Bulletin E1111 to THE BRISTOL COMPANY, 113 Bristol Road, Waterbury 20, Conn.

Many ranges carried in stock for immediate delivery

LOOK AT THESE FEATURES!



NEW MEASURING MECHANISM — High-quality, accurate, dependable Bristol moving-iron mechanism used in all models.

MAGNETIC DAMPING — all models equipped with aluminum vane and alnico magnet damper which gives maximum speed of response possible with minimum overshoot.

PEN MOUNTING — Pen-arm mounting shaft firmly supported at both ends — eliminates trouble from back-lash and lost motion. Pen arm is readily removed and replaced.

IT'S MADE IN CONNECTICUT

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **56** on inquiry card.

To detect and measure static or dynamic acceleration in ranges from ±2 g to ±100 g, the Model F accelerometer is available for applications requiring miniature components.

Weighing less than one ounce, this accelerometer can be attached to light machine parts without altering their dynamic performance, or it may be inserted into small spaces previously inaccessible for vibration measurements. At no sacrifice in performance, extremely small size and weight are emphasized in the Model F accelerometer.

Please request Bulletin No. 4.0.

Statham
LABORATORIES
• Los Angeles 64, Calif.

For more information circle **57** on inquiry card.

NEW INSTRUMENTS

detectors: one used by itself for detection of thermal neutrons; the other (surrounded by a paraffin block and a cadmium shield) is sensitive only to neutrons with energies above approx. 1 ev., is insensitive to gamma radiation of approx. 1 r/hr.—*Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **244** on inquiry card.

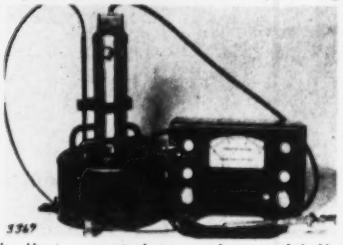
Preflush Flow Counter

New "Model DD7 and DD8" internal sample counter has three chambers; for counting, for preflushing, and for changing samples. "DD7" accepts sample pans up to 1-in. diameter; "DD8" accepts samples up to 2-in. diameter. May be used either in Geiger or proportional region; exceptionally long plateaus; said to be ideal for counting alpha and weak beta particles.—*Detectolab, Inc., 6544 Sheridan Rd., Chicago 26, Ill.*

For more information circle **245** on inquiry card.

Scintillation Counter

New "Ferret," ultra-sensitive scintillation survey meter for uranium and oil prospecting, consists of (1) scintillation detector head using an oversize gamma-sensitive crystal op-



tically connected to a photomultiplier tube, (2) count rate meter with six ranges of sensitivity and four variable time constants. "Ferret" can be used for any type of geophysical survey calling for detection and logging of extremely weak gamma radioactivity levels, from a low-flying aircraft or moving vehicle.—*The Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.*

For more information circle **246** on inquiry card.

COMPUTING

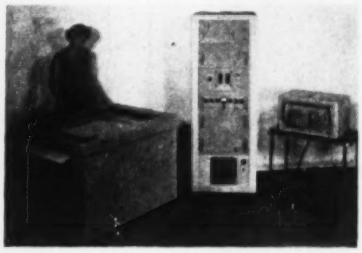
Foot Pedal Control for Analog Computer

New foot pedal control added to maker's "Square Root Planimeter" increases speed of operation of this mechanical analog computer for flow chart totalizing and cost accounting of 3-in. graphic panel strip-chart recorders, which offers true square root extraction with integration over full range of flow without approximation.—*Librascope, Inc., 808 Western Ave., Glendale, Calif.*

For more information circle **247** on inquiry card.

Automatic Plotting Board

New "Electroplotter Model G" accepts inputs from punched cards, punched tape and keyboard; plots on a 30x30-in. surface with an accuracy of one part in 1500, or 0.02 in., whichever is greater. Numerical input of

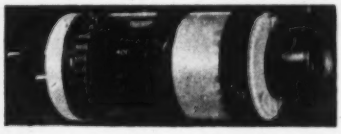


±9999 may be expanded to full scale or compressed to ⅓ full scale in both *X* and *Y*, and origin placed at any desired location. Other features include multiple symbol printing, serial keyboard, plug-in component construction, and light bank indication of numbers in *X* and *Y* registers.—*Benson-Lehner Corp., Dep't A, 2340 Sawtelle Blvd., West Los Angeles 64, Calif.*

For more information circle **248** on inquiry card.

Plug-in Resistance Decade

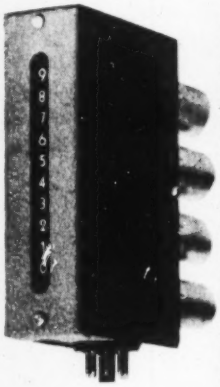
New "GEDA" plug-in decade resistance unit for analog-computing equipment, etc. was designed by Goodyear Aircraft Corporation and maker, and miniaturized in maker's labora-



tories to half size of original unit. Now 4 in. long. Four stock types with maximum resistance value of 1 and 10 megohms and 1 and 10 kilohms, but can be built to other specs. Can be set to within 0.1 percent of any range value.—*Dep't. KP, Telex, Inc., E-A Div., Telex Park, St. Paul, Minn.*

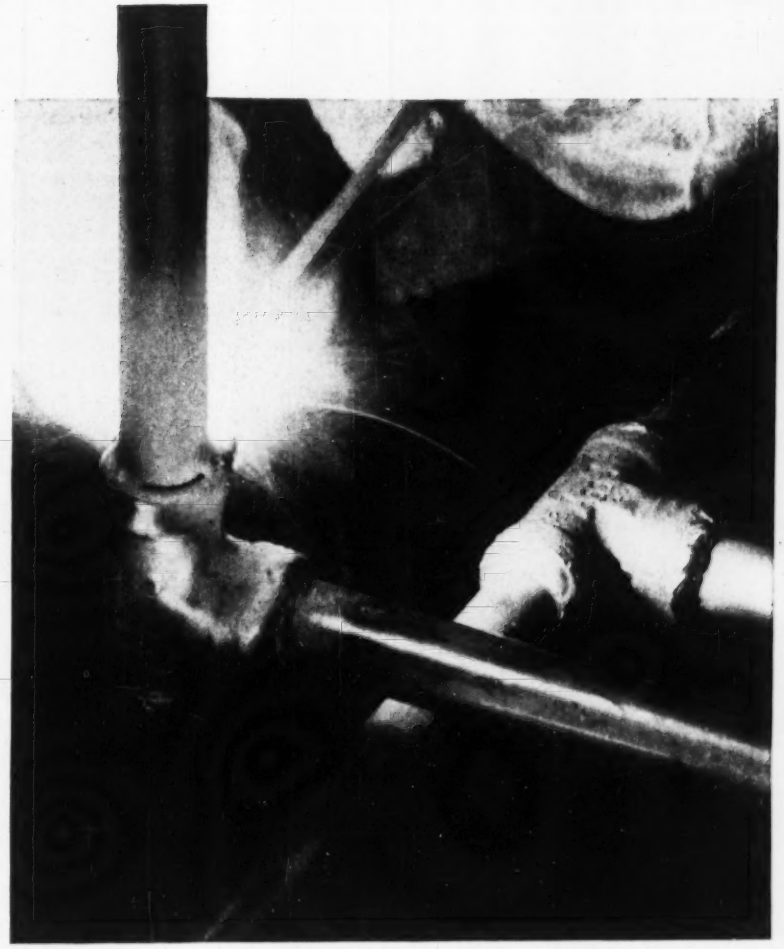
For more information circle **249** on inquiry card.

Decimal Counting Units



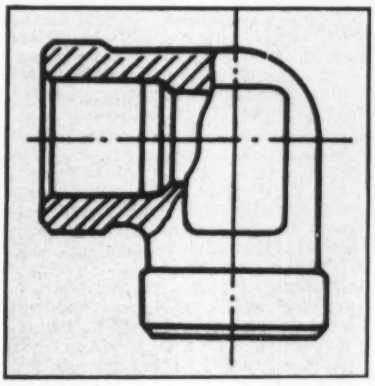
New "Types 100A and 100B" are direct-reading plug-in electronic counters. Each unit counts (and indicates by neon bulb) input pulses from 0 to 9; tenth pulse resets counter to 0 and simultaneously produces an output pulse. To increase counting capacity, units are connected in cascade with output of one unit fed to input of next unit. Example: five units count up to 99,999 and reset to 00,000 in 100,000th pulse, when last unit produces an output pulse which may be used for trigger-

Announcing Parker Weld-lok tube fittings

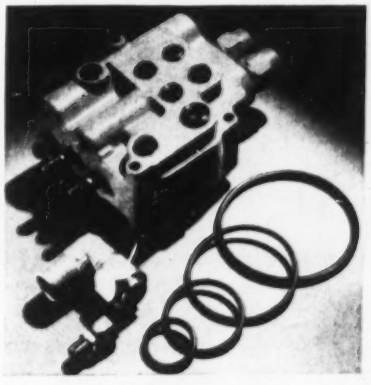


machined from high-quality steel or stainless steel bar stock and forgings . . . for tubing ¼ through 2 inches O. D.

Simply insert tube; then weld! No wonder Parker's new *Weld-lok* tube fittings are so easy to use . . . for applications involving extreme temperatures, corrosion conditions, or wherever permanently welded joints are needed. With *Weld-lok* fittings, you get permanently tight lines . . . unaffected by vibration, shock, or thermal distortion. They're offered for tubing sizes ¼ through 2 inches O.D.—steel or stainless steel.



Tapered socket of *Weld-lok* fittings aligns and holds tube, while you weld. You don't need special fixtures or equipment to make correctly proportioned weld.



What other Parker products interest you? *Triple-lok* flare tube fittings or *In-tru* flareless tube fittings for instrumentation? Hydraulic control valves? O-rings?

TUBE AND HOSE
FITTINGS DIVISION
Section 410-Q
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

Send New Parker *Weld-lok* Catalog No. 4370

Name _____ Title _____

Company _____

Address _____

City _____ State _____

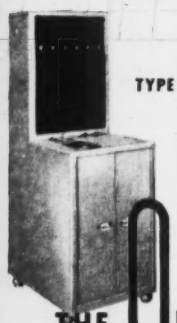
Mail this coupon for your copy of *Weld-lok* Catalog No. 4370. We will also send you the name of your nearest Parker distributor for *Weld-lok* tube fittings.

Parker

Hydraulic and fluid system components

For more information circle **58** on inquiry card.

thirty
times
as
sensitive
yet drift-free



THE OFFNER
DYNOGRAPH

0.001 volt input d-c gives 70 mm. deflection with this high-speed direct writing oscillograph, as compared to only 2 mm. with the most sensitive competitive unit—and with zero drift.

The Dynograph with *one amplifier* is used for all types of inputs—d-c, a-c, or reluctance gauges for measuring speed, temperature, position, vibration, and other variables. Exclusive, patented, chopper amplifier design makes it sensitive, stable, and versatile—greatly increasing the scope of direct writing oscillographs.

Get bulletin L742—compare the Dynograph with all competitive models—it's thirty times as sensitive.

OFFNER ELECTRONICS INC.
5326 N. Kedzie Avenue
Chicago 25, U. S. A.

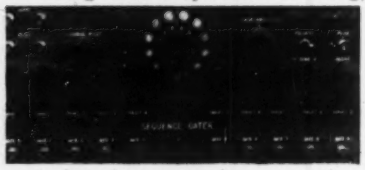
For more information circle **59** on inquiry card.

ing an external device. New units employ a newly-developed counter circuit and long-life components for use in computers. Speeds: "Type 100A" from 40 kc. to 0 cps.; "Type 100B" from 100 kc. to 0 cps.—*Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J.*

For more information circle **250** on inquiry card.

Variable-scale Counter

New variable scale counter uses multiple outputs of maker's beam switching tube to perform counting,



control and sequencing operations which might otherwise require several pieces of equipment. Basically a high-speed decimal counter, it also has a self-contained electronic reset circuit that can be set to count by any number from 2 to 10. In straight decimal counting, it will handle pulse inputs up to 500 kc.; speeds are lower when counting by less than ten, because of fixed delay in reset circuit.—*Electronic Instruments Div., Burroughs Corp., 1209 Vine St., Philadelphia, Pa.*

For more information circle **251** on inquiry card.

LABORATORY

Spectrophotometer

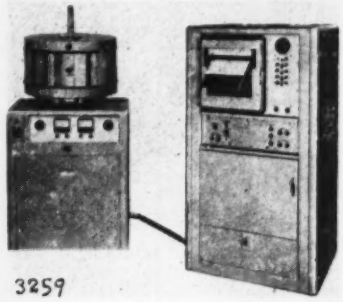
New ultraviolet and near-infrared spectrophotometer, first commercially-available instrument designed specifically for near-infrared region, has lead sulfide detector and quartz monochromator permitting high-speed transmittance

recording at cost and performance said to be unmatched by conventional infrared instruments. Using a photomultiplier detector for UV work, new instrument offers a guaranteed wavelength range of 2.2 to 2.7 microns. Unique "double-beam ratio principle" system for percent transmittance recording provides stability of double-beam operation with a single receiver, and 480-per-second beam chopping takes full advantage of sensitive PbS detector. At highest scanning speed, near-infrared is traversed in one minute; extremely low speeds available for extreme resolution.—*Beckman Div., Beckman Instruments, Inc., Fullerton 1, Calif.*

For more information circle **252** on inquiry card.

X-ray Spectrometer

New "XIQ" is a curved-crystal multi-channel x-ray "Quantometer" designed specifically for rapid non-destructive chemical analysis of metals, powders and liquids. It represents a new method, since previous equipment



of this type, using flat crystal, was limited to one channel (analysis of one element at a time), whereas "XIQ" permits analyses of as many as eight elements at one time. Another advantage is that console unit records exact percentage of elements found in sample and autographs this information in less than two minutes.—*Applied Research Labs., Glendale, Calif.*

For more information circle **253** on inquiry card.

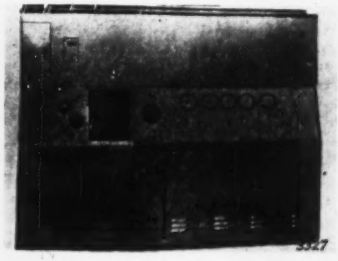
Coatings Kit

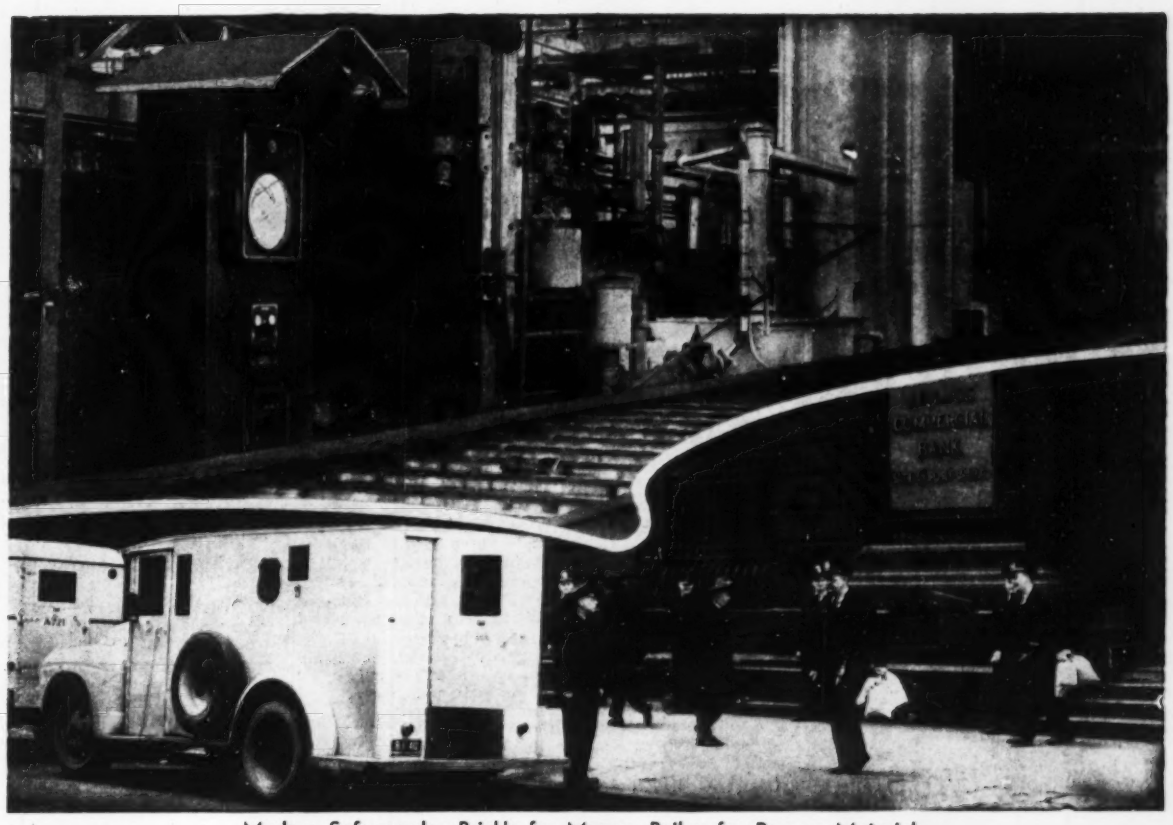
New "S31 Basic Laboratory Kit" comprises six electrically-conductive silver coatings, six resistance coatings, six accessory chemicals, manuals, data folders, etc. Materials are those which, during the past five years, have been the most widely used and the most effective aids in solving research and design problems in a wide variety of industries.—*Micro-Circuits Co., New Buffalo, Michigan.*

For more information circle **254** on inquiry card.

Direct reading Spectrometer

New "Atomcounter" is said to embody many optical, electronic, and mechanical design innovations: Double optical system and focal deck whereby instrument may be used photographically for qualitative or semi-quant analysis simultaneously with or alternately to direct-reading measurements. (It is also furnished as a single-deck direct-reading system for analysis of simple steels and cast iron.) Exceptional rapidity: complete analyses normally require less than one minute. Results show standard deviations of 1 to 2 percent. Ease of servicing and repair: unitized construction principle using simple and inexpensive components. Important feature: two collimating mirrors pro-





Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

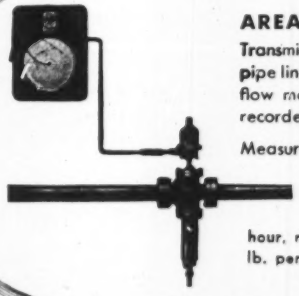
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials.



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 96,000 lb. per hour.

BAILEY METER COMPANY

1041 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls
TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

For more information circle 60 on inquiry card.

You get full 180° visibility . . . so you can read the liquid level from any point from which you can see the gage . . . with the New Convex Scale now available on Jerguson Truscale Remote Reading Gages. Scale markings are directly on the convex face and the indicator goes clear around the convex surface. You can stand at one end of the control room and instantly check your whole line up of Truscale Gages.

Jerguson Truscales give you instant remote readings of liquid levels of waste heat boilers, tanks, etc. . . . with the amazing accuracy of ½ of 1% of scale reading. And with the New Convex Scale you make these readings from any angle . . . accurately, without distortion. Truscales also available with lights, horns and Truscale Repeaters.

Write today for complete data on Truscale Gages with the New Convex Scale.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.

Offices in Major Cities
Bailey Meters & Controls, Ltd., London, Eng.
Controle Bailey, Paris, France

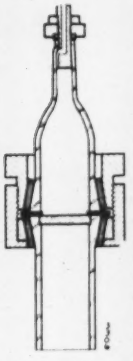
For more information circle **61** on inquiry card.

NEW INSTRUMENTS

duce two identical spectra, one above the other, each at full intensity: (1) permits measuring two lines close together, one in lower spectrum, the other in the upper; (2) provides double normal space for mounting photomultipliers; (3) makes it possible to employ photomultipliers directly behind almost all lines. Photomultiplier output is quantized into pulses, applied to a scaler, which ends up with a number of counts proportional to intensity.—*Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.*

For more information circle **255** on inquiry card.

Chromatographic and Ion-exchange Columns

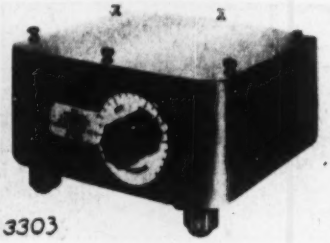


New "Ultramax" column permits variable column lengths with a single unit; removable filter disks permit selection of various filter porosities as required; "Ultramax" valve requires no lubricant, permits fine control of effluent; "F&P" glass-to-glass coupling can be quickly disassembled for cleaning. Stock sizes in ¼-in. to 1-in. heavy-walled tubing with porcelain filter disks; special columns to order.—*Fischer & Porter Co., 194 Jacksonville Road, Hatboro, Pa.*

For more information circle **256** on inquiry card.

Monochromatic Illuminator

New UV Monochromatic Illuminator, convenient to use with microscopes, colorimeters, photometers, etc., is designed to yield monochromatic illumination at any chosen wavelength



between 0.22 and 0.44 microns. Dispersing element is a reflection-type replica grating, having 14400 lines per inch.—*Farrand Optical Co., Inc., Bronx Blvd. & E. 238th St., New York 70, N. Y.*

For more information circle **257** on inquiry card.

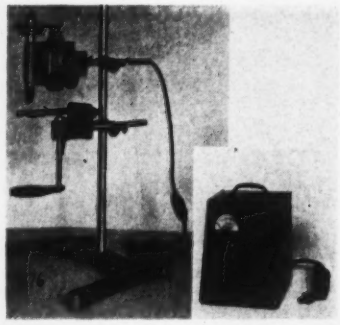
Flushing Oil for Vacuum Pumps

New "Cenco Hyvac Flushing Oil," developed especially for flushing mechanical vacuum pumps without risk of contamination from detergents or volatile additives, is said to be ideal for removing old oil, sediment and dirt which may accumulate in mechanism. One or two flushings, followed by a refill with "Cenco Hyvac Oil," will prepare a pump for immediate use.—*Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.*

For more information circle **258** on inquiry card.

Electroanalysis Set

New "Single Position Electro-Analysis Apparatus" provides multi-position operating efficiency; permits an-



alyses involving stationery electrodes or a rotating anode. Components: electrode holder and cell support, heavy-duty support, d-c. power supply delivering 1-5 amps., and 3-speed stirrer.—*Eberbach Corp., Ann Arbor, Mich.*

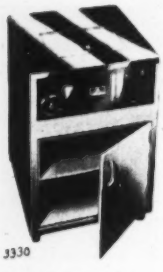
For more information circle **259** on inquiry card.

Proportional Counter for X-ray Diffraction

New proportional counter tube and proportional counter preamplifier, for use with maker's x-ray diffraction unit, are said to provide "a many-fold increase in efficiency and a drastic reduction of error in the higher frequencies," and other advantages. Both accessories, acting together, perform linearly over 5 times range of argon-filled multichamber Geiger tubes, and about 20 times range of linearity of typical single-chamber Geiger tubes. New counter assembly has less than 1 usec. resolution time.—*General Electric, 4855 Electric Ave., Milwaukee 1, Wis.*

For more information circle **260** on inquiry card.

Centrifuges



New "Model 10 Electrifuges" include such new features as Formica top which can be used as a working top; storage space for accessories; built-in 6000 rpm. speed indicator; 3-hour electric timer; electric brake, safety switch on cover; Powerstat stepless speed control; etc. Over 300 different types of heads to choose from.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **261** on inquiry card.

Chromatography Jars

New rectangular chromatography jars are said to have important advantages. Trough capacity is double that of round jars of comparable size, and rectangular jars have added convenience of occupying less bench space. 8x12 jars, 21 in. high, are available, with or without complete trough assemblies and lids. Four solvent trough

IT'S IDEAL...

For a New High in Turntable Instrument Testers!

Model 1252—Various mounting brackets available.

This turntable is just ONE of the many extremely accurate tables made by IDEAL Laboratories. A complete line of turntables, combination turn and oscillation tables and roll-pitch-yaw tables of standard design to fit your needs are now available. If a special turntable not listed among our many standard models is required, we can make it for you. Write for full information!

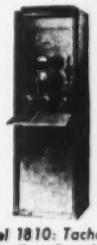
In the measurement of pressure up to 80" of mercury, we can furnish either absolute or differential pressure measuring instruments to unbelievably close accuracy. These instruments are sensitive to less than a thousandth of an inch.

IDEAL LABORATORY TOOL & SUPPLY CO. of Cheyenne WYOMING

RELIABILITY · VERSATILITY · IDEAL · PERFORMANCE

Model 1406R: Instrument Test Table

Model 1052: Automatic Indicating Barometer



Model 1810: Tachometer Test Stand

For more information circle **62** on inquiry card.

PRECISION GAS-FILLED CAPACITORS
(LOSSFREE STANDARD CAPACITORS)

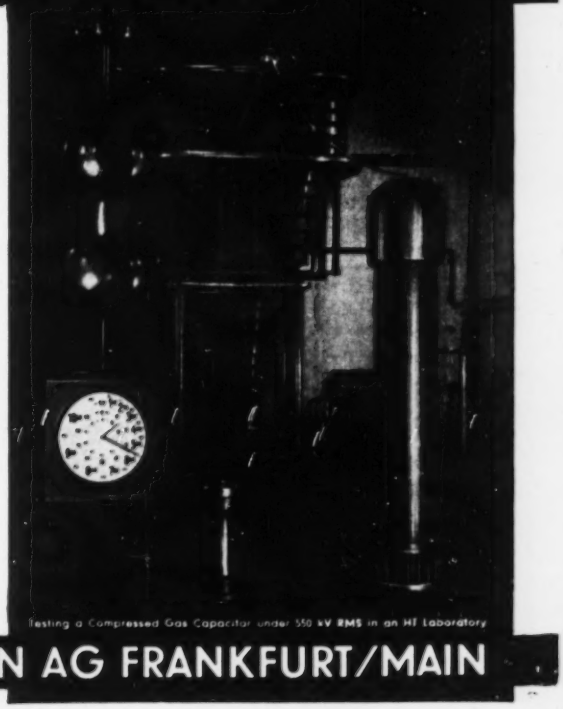
for use in connection with:

High Voltage Measurements
Schering Bridges
E. H. T. Transformer Test Sets

Supplied to leading laboratories all over the world

BELGIUM:	Ateliers de Constructions Electriques de Charleroi
CANADA:	Canada Wire & Cable Co. Ltd. (Kitimet Project of the Aluminium Company of Canada, British Columbia)
DENMARK:	Københavns Belysningsvæsen, Copenhagen
ENGLAND:	National Physical Laboratory, Teddington
FRANCE:	Ateliers de Constructions Electriques de Jeumont
GERMANY:	Physikalisch-Technische Bundesanstalt, Abteil. II, Brunswick
INDIA:	College of Engineering, Banaras Hindu University, Banaras
ITALY:	Università di Napoli, Laboratorio di Elettrotecnica, Naples
JAPAN:	Showa Electric Wire & Cable Co. Ltd. Kawasaki
NETHERLANDS:	Gemeente-Energiebedrijf, Rotterdam
SPAIN:	Cia. de Inversiones, S. A. (Pirelli), Barcelona
SWITZERLAND:	Emil Haefely & Cie. A. G., Basle

Ask for bulletin No. Aa 103



Testing a Compressed Gas Capacitor under 550 kV RMS in an HF Laboratory

H&B HARTMANN & BRAUN AG FRANKFURT/MAIN

For more information circle **63** on inquiry card.

BARBER COLMAN

ultra-sensitive relays

selected for new Automatic Coil Checker by Associated Research, Inc.

Manufacturer of precision instruments, Associated Research Incorporated, Chicago, Illinois, also builds custom test equipment such as the special coil checker shown above.

This test unit automatically checks for high potential breakdown, shorted turns and correct resistance in a seven-second time cycle per coil. As the relay for the resistance checking circuit, a Barber-Colman Micropositioner was chosen. A Micropositioner is also used in Associated Research's Audio Hypot in an alarm circuit to detect 500 micro-amperes of a-c current leakage in the test specimen.

Ideal for hundreds of other industrial applications, Barber-Colman Company's ultra-sensitive d-c polarized relays are available in a wide range of coils, enclosures and mounting details.

Write today for Bulletin F3961-2

BARBER-COLMAN COMPANY
Dept. K, 1415 Rock Street, Rockford, Illinois

For more information circle **64** on inquiry card.

NEW INSTRUMENTS

assemblies can be supported crosswise at any desired height on a simple stainless steel insert, or two assemblies can be supported lengthwise.—*Research Specialties Co.*, 1148 *Walnut St., Berkeley 7, Calif.*

For more information circle **262** on inquiry card.

Vacuum Stirrer

New "Stir-O-Vac" for stirring under vacuum without mercury seal is supplied with a high-speed ¼-hp, series motor for operation up to 20,000 r.p.m. Motor comes complete with special chuck and 3-prong clamp for clamping to support rod. "Stir-O-Vac" can also be furnished less cruciform impeller and shaft for user to supply special blades.—*Labline, Inc.*, 217 *N. Desplaines St., Chicago 6, Ill.*

For more information circle **263** on inquiry card.

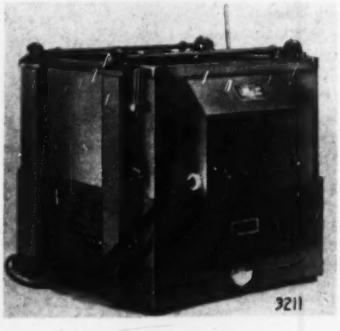
Controlled Stirrer

New "No. 3650" thyratron-controlled adjustable-speed stirrer features variable speed at full torque, direct-drive and gear drive shafts both extended and usable. Direct, about 400-4000 rpm. steplessly variable; gear, about 1/8 of armature speed. Motor runs in either direction.—*Ace Glass Inc., Vineland, N. J.*

For more information circle **264** on inquiry card.

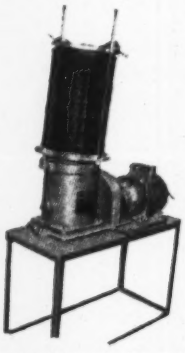
Water-bath Shaker

New "Reciprocating Constant Temperature Water Bath Shaker" is designed and built for continuous operation. Features: changeable platforms giving great versatility to sizes and styles of flasks and bottles; variable speed range of 75 to 200 strokes per minute; adjustable stroke of ½-in., 1-in., and 1½-in.—*New Brunswick Scientific Co.* 10 *Hiram St., New Brunswick, N. J.*



For more information circle **265** on inquiry card.

Test Sieve Vibrator



New Laboratory Test Sieve Vibrator, by its simultaneous gyratory and vibratory movements, speedily passes particles through screens and segregates different sizes in proper sieves. Movement of 10-in. table is not rotation but nutation—like an inclined disc rolling around its perimeter. As table nutates, it simultaneously vibrates a fraction of an inch 300 times a minute. Table accommodates 8-in.-diam. test sieves. Motion is started by setting a 0-to-60-minute timer, and automatically stopped.—*Arthur S. La Pine & Co., 6001 S. Knox Ave., Chicago 29, Ill.*

For more information circle **266** on inquiry card.

Glassware Shaker

New multi-purpose shaker is designed to carry a wide variety of laboratory flasks, test tubes, etc.

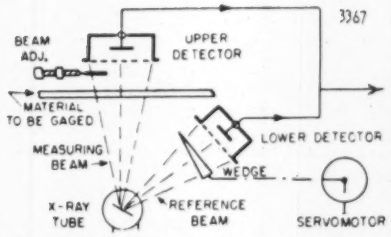
Clamps are adjustable two ways. Speed is controlled by a rheostat; and a timer aids in reproducing shaking periods. Action duplicates hand motion.—*Palo Laboratory Supplies, Inc.*, 81 *Reade St., New York 7, N. Y.*

For more information circle **267** on inquiry card.

DIMENSIONAL

X-ray Thickness Gage

New "X-Ray Thickness Gage" continuously measures aluminum foil as thin as 0.0003 in. and steel as thick as 0.075 in. with accuracy of 1 percent; utilizes a split x-ray beam and an automatic null balance system (only a part shown in diagram); can be furnished with dual range or even three ranges if required. It indicates deviations from settings; and a recorder may be placed in circuit to give direct readings of thickness. Pass line may vary anywhere



in air gap from top head to bottom head without any change in reading. —*Pratt & Whitney, Div. Niles-Bement-Pond, West Hartford 1, Conn.*

For more information circle **268** on inquiry card.

Small-hole Gage

New "Kwik-Chek" measures internal diameters of small holes from 0.020 in. to 0.130 in., is guaranteed accurate to within 0.0005 in. over

entire range. User can make measurements using one hand. Built-in 2½X magnifier enables user to read to nearest half-thousandth.—*New Standard Div., U. S. Expansion Bolt Co., York, Pa.*

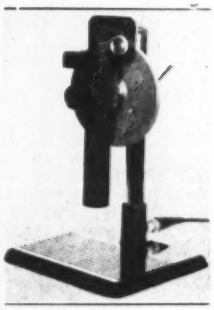
For more information circle **269** on inquiry card.

Automatic Leveling Tool

New "Cowley Compactic Automatic Level" features novel optical principle, employs no cross hairs, bubbles or leveling screws. No focusing is necessary. Camera-sized unit need only be placed on its tripod or wall-top stand to indicate automatically whether target is level. —*Compactic Div., Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

For more information circle **270** on inquiry card.

Alignment and Angle Collimators



New 10-second-arc model of maker's collimator is equipped with a 10-in. dial and vernier. High-power eyepiece enables matching angles to a master angle or sine bar to 5 seconds. Flatness of machine beds, etc., can be checked to less than 0.0001 in. per inch with the aid of regular mirror accessory. No distances have to be measured or height scales used:

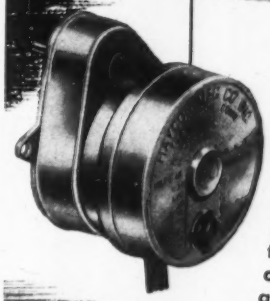
NEW CONCEPTS

NEW POTENTIALS

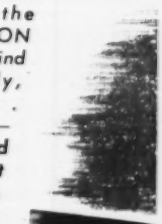
HAYDON*

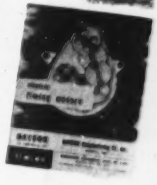
Because manufacturers must have better products, they rely on **you** *— the designers and engineers who have the ability to apply skill and experience with* **IMAGINATION** *— to develop new and better products and methods! Ready to work with you are industrials with the same vision and creative talents. In the field of timing motors, HAYDON is such a company.*

because new IDEAS take TIME and TIMING!



If 60 cycle, 400 cycle, or d-c timing motors are to be used in your product or process, call in the nearby factory-trained HAYDON Field Engineer. He can help you find the right motors for precisely, dependably using time . . . controlling time . . . metering time — **for bettering performance and opening new horizons to product and process use.** *Clip and mail the coupon for his name . . . and for an informative catalog —* **today!**





HAYDON AT TORRINGTON

HEADQUARTERS FOR TIMING

A SUBSIDIARY OF GENERAL TIME CORP.

HAYDON Manufacturing Company, Inc.

2035 ELM STREET, TORRINGTON, CONN.

☐ Send me the name of the nearby HAYDON Field Engineer

☐ Send me catalog, "Electric Timing Motors"

NAME _____

POSITION _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE ____ STATE _____

*Trade Mark Reg. U. S. Patent Office

For more information circle **68** on inquiry card.

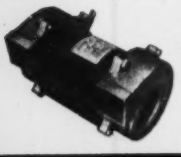
15 Horse Power in a 7"x 11" case!

A typical example of American Electric engineering

This 400 cycle 3 phase motor is a special custom-developed aircraft design. Rated at 15 h.p. continuous duty at 11,500 r.p.m., it actually produces 19 h.p. on intermittent duty, yet occupies less than ¼ cubic foot. Weight is 32 lbs.–approximately ½ h.p. per lb. Fungus-proof, corrosion resistant, meets AND 20002 type XIIB mounting specifications. Temperature range: −67° to +131° F. Motor length: 7", Coupling extension 4".

MINIATURE MOTORS for all PURPOSES!

American Electric Motors are also built in an almost unlimited range of miniatures for 60 and 400 cycle operation as well as variable frequencies. All feature low weight, compact size and meet high temperature requirements. Supplied in induction or synchronous types for motor drives, propeller fans and centrifugal blowers. Wire, write or phone for data and quotations.



Also Manufacturers of High Cycle Motor-Alternators and A.C. Industrial Motors.

AMERICAN ELECTRIC MOTORS

DIVISION OF AMERICAN ELECTRONICS, INC.
FIELD ENGINEERING REPRESENTATIVES:
Silver Spring (Md.) • Boston • Buffalo • New York City • Chicago • Dallas • Kansas City • Wright Field • Minneapolis • Seattle • Montreal • Toronto
JOE DAVIDSON & ASSOCIATES, Los Angeles

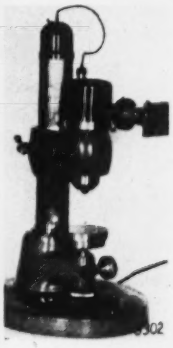
For more information circle **66** on inquiry card.

NEW INSTRUMENTS

collimator can be used from 1 in. to 20 ft. away without focusing. New focusing lens accessory can be used as a layout tool: each graduation equal to 0.0005 in. lateral or cross travel of machine.—*Mitchell Scientific, 70 N. Columbus Ave., Mt. Vernon, N. Y.*

For more information circle **271** on inquiry card.

Interference Microscope

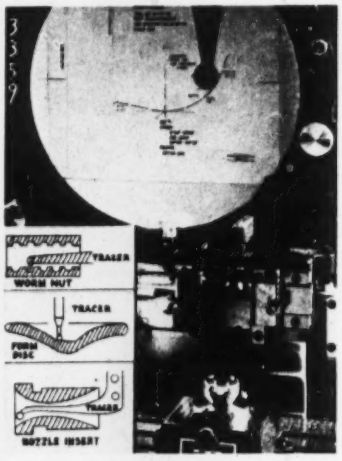


New Interference Microscope, for measuring roughness of polished, lapped and ground surfaces, is adaptable for visual or photographic use. Simplicity of operation permits high-precision interferometry and measurement of surface roughnesses of the order of one microinch. Advantages over electronic and mechanical surface-measuring instruments include precise and detailed measurement of surface irregularities whose surface rate of change is too small to be measured or detected by methods giving average contour measurement.—*Farrand Optical Co., Inc., Bronx Blvd. & 238th St., New York 70, N. Y.*

For more information circle **272** on inquiry card.

Optical-gaging Tracer

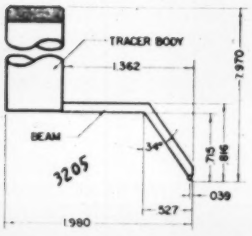
New "Model 24 Coordinate Tracer" enlarges versatility of optical projection gaging. By tracing contours and transmitting tracing motion to a target in projector's light beam, it makes possible accurate gaging of dimensions heretofore difficult or impossible to gage.—*Optical Gaging Products, Inc., 26 Forbes St., Rochester 11, N. Y.*



For more information circle **273** on inquiry card.

"Dogleg" Tracer

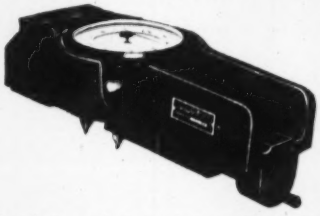
New "Profilometer Type GF Tracer," for measuring surface roughness on internal tapers and shoulders and on other surfaces that can only be reached by a tracer with a dogleg beam, can also be used on any other internal or external surface where geometry of work permits and where part can be mounted with work surface approximately horizontal.—*Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.*



For more information circle **274** on inquiry card.

Spacing Comparator

New low-cost portable spacing comparator can be operated by unskilled workers, checks spacing on flat and circular work or tools to within 0.0001 in.; may be used as a portable lead comparator for inspecting threaded products. Range 1/16 in. to 5½ in. Various points available such as: ball, cone, flat and special forms. Extra accessory equipment: standard or special master setting gage.—*Jerpbak-Bayliss Co., Solon Road, Solon, Ohio.*

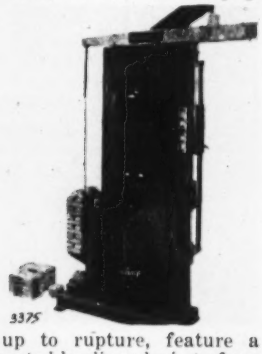


For more information circle **275** on inquiry card.

MECHANICAL TESTING

Creep-test Machines

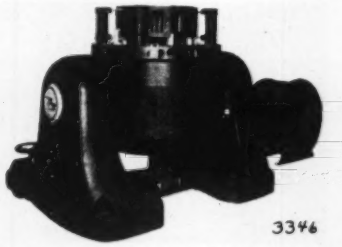
New 12,000-lb. testing machines for determining stress required to rupture specimens, as well as creep properties up to rupture, feature a new ball-seated loading clevis to free specimen from bending moments which give erroneous results. Machines can be furnished ready to function, complete with integral electrical equipment, said to be an innovation. Also available: electric furnace, lever leveler, hydraulic recoil absorber to prevent damage and noise, and motorized elevator to lift load from beam.—*Riehle Testing Machines, Div. American Machine & Metals, Inc., East Moline, Ill.*



For more information circle **276** on inquiry card.

Vibration Exciter

New "Model C-100," said to be largest capacity electromagnetic shaker in existence, now delivers up to 12,500 lbs. force. Range 5 to 2000

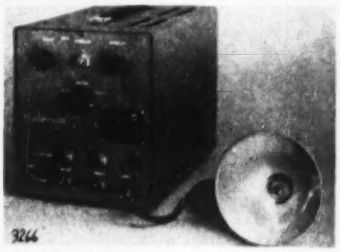


cps. New cooling system has been relocated. Shaker can be tipped for horizontal drive. Vibration isolators built into trunnions obviate need for special floor construction.—*The MB Mfg. Co., Inc., New Haven, Conn.*

For more information circle **277** on inquiry card.

Vibration Analyzer

New "Flash-Lok" portable stroboscopic instrument for vibration and shock analysis utilizes a synchronized light source with excitation derived

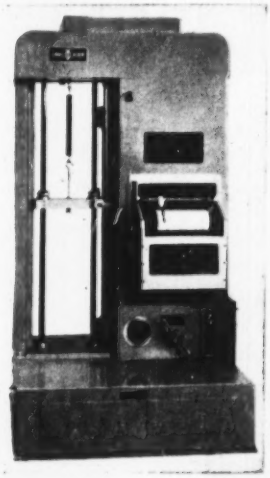


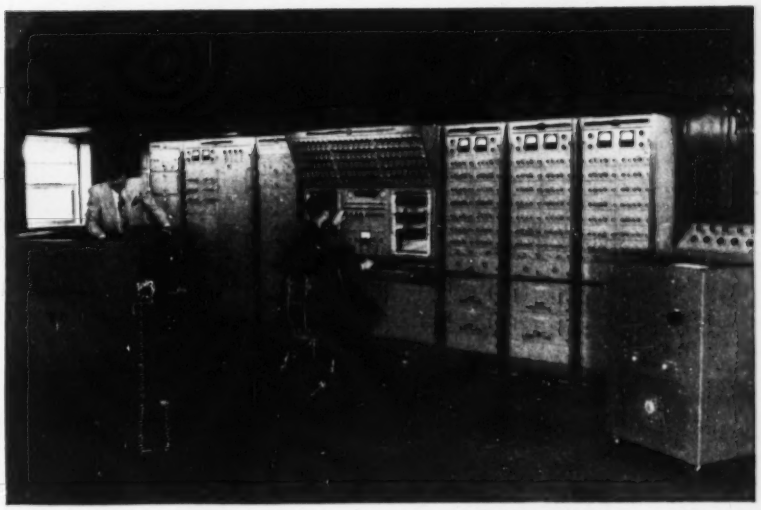
directly from electrically-driven vibration equipment, or from an accelerometer attached to mechanical equipment. Light flashes may be locked exactly to vibration frequency, or may differ for "slow motion."—*York Div., Bendix Aviation Corp., York, Pa.*

For more information circle **278** on inquiry card.

"Table-top" Universal Testing Machine

New 200-lb.-capacity "Electromatic," for tensile testing of fabrics, fine metal wire and other materials, also permits flexure and compression





Electronic Associates Computation Center near Princeton, N. J.

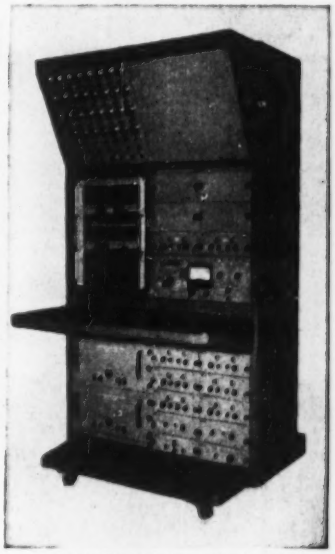
PRECISION ANALOG COMPUTERS... rapidly and accurately solve complex engineering problems

At the EA Computation Center you may solve complex problems in Applications Engineering, Simulation, and Engineering Design by renting EA Analog Computation Equipment by the hour, week, or month.

Scientists, engineers, and mathematicians experienced in the use of analog computers are available to assist in problem solution.

PRECISION ANALOG COMPUTATION EQUIPMENT IS ALSO AVAILABLE FOR PURCHASE.

Throughout the design of this computing equipment the objective was to produce the most accurate, versatile and dependable equipment possible at a reasonable price. In achieving this end, many of the latest advances in the art have been incorporated which contribute to the superiority of this equipment.



EA Precision Analog. Computer, Type 16-31R

If you state your interest, we will be glad to send you applicable data. Write to Dept. IA.

Visit our booth at the First International Automation Exposition in New York, Nov. 29 through Dec. 2.

PRECISION ANALOG COMPUTING EQUIPMENT FOR SOLVING PROBLEMS IN DYNAMICS

ELECTRONIC ASSOCIATES

LONG BRANCH • NEW JERSEY

For more information circle **67** on inquiry card.

convert

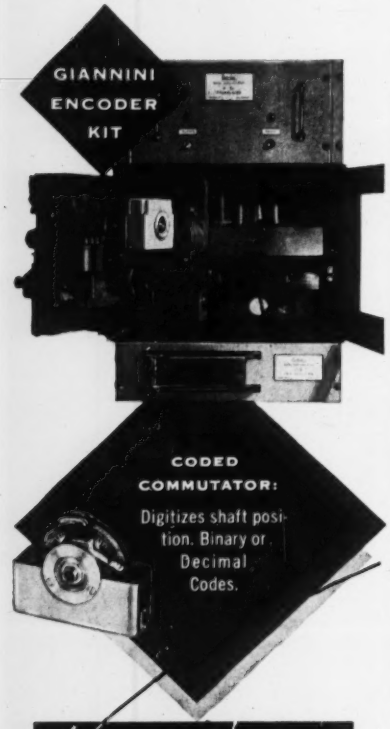
SELF-BALANCING POTENTIOMETERS TO

digital read-out

PRINTED TAPE • PUNCHED CARD
PUNCHED TAPE

Complete... Easy to Install... Reads from 0-1000; Accuracy ±0.1%. A complete system kit for obtaining digital information from standard self-balancing potentiometers. Easy to install, complete with all necessary hardware, this conversion does not affect the accuracy of the recording instrument, and no modification of the potentiometer is required. Readings can be taken while the recording pen is moving.

Non-linear calibrations available for use with thermocouple applications.



Giannini

SALES ENGINEERING OFFICES:
NEW YORK, N.Y.—580 FIFTH AVE.— JUDSON 6-7500
LOS ANGELES, CALIFORNIA— RYAN 1-7182

Laboratory Apparatus Division

G. M. GIANNINI & CO., INC.
PASADENA 1, CALIF.

For more information circle **68** on inquiry card.

NEW INSTRUMENTS

tests to be made. Eight testing ranges (lowest 0.4 lb.) instantly available. In place of dial indicator, maker's "XY Electronic Recorder" records load and specimen extension. Choice of strain magnifications from 0.5X to 40X.—*Tinius Olsen Testing Machine Co., 1234 Easton Road, Willow Grove, Pa.*

For more information circle **279** on inquiry card.

Humidity Cabinets

New controlled relative humidity cabinets feature relative humidity controllable at any point from 50 to 99 percent and a dry-bulb temperature range from ambient to plus 70 C. High humidity without condensation on test specimens is accomplished by exclusive counterflow air baffle-cooling coil arrangement. Relative humidity controlled within 2 percent at any point; dry-bulb temperature accurate to 1 deg. C. Four standard sizes from 1.4 to 10.0 cu. ft. capacity. 115-v.ac. operation is standard.—*Blue M Electric Co., 306-308 W. 69th St., Chicago 21, Ill.*

For more information circle **280** on inquiry card.

Concrete Tester

New "Model LT-500," said to be "the lowest-priced laboratory testing machine on the market," will perform an unusually wide variety of tests in conformance with ASTM and ACI specs; comprises a basic machine with five accessory groups, four of which may be purchased later: (1) for testing cylinders and cubes; (2) for testing building blocks; (3) for testing compression and modulus of rupture of brick by center-point loading; (4) for testing deflection and modulus of cast beams and lintels by third-point loading; (5) for testing 8x18-in. building units in tension (must be factory installed).—*Forney's Inc., Box 310, New Castle, Penna.*

For more information circle **281** on inquiry card.

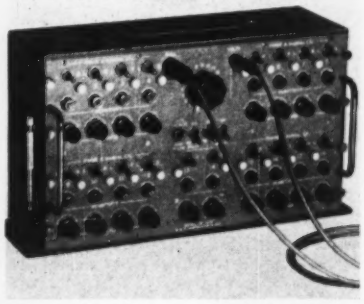
Strain-gage for Concrete

New "SR-4 Valore Type" concrete embedment strain gage incorporates an "SR-4" gage with an effective length of 3 in., sealed in a brass envelope 0.01 in. thick and 0.5 in. wide; over-all length 6 in. Leads are a twisted pair of solid No. 20 conductor, Neoprene-insulated to ⅛ in. diam. and sealed with wax in an opened end of brass envelope. Two types of gage: One is self-temperature-compensated over range of 0-100 F.; the other is not so compensated.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **282** on inquiry card.

Strain-gage Bridge

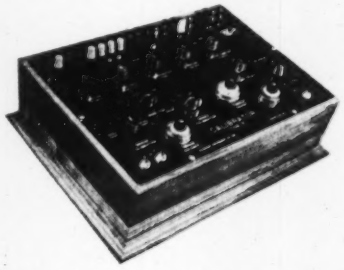
New "Model 18-200 Automatic Bridge-Balance & Calibrating Unit" accommodates 18 channels in same size chassis as 12-channel model with no feature sacrificed. Like its predecessor, it provides means of adjusting and matching any resistance-pickup or strain-gage bridge to any oscillograph galvanometer for direct recording.—*B & F Instruments, Inc., 4732 N. Broad St., Philadelphia 41, Pa.*



For more information circle **283** on inquiry card.

Strain Gage Calibrator

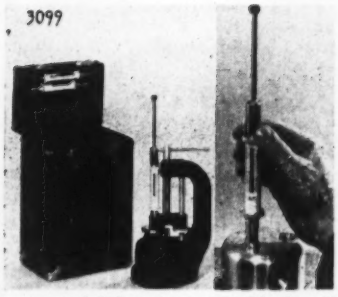
New "Type C" is for use with 1-, 2-, and 4-active-arm pickups. By means of shunt and series resistors, a calibration is obtained directly in pressure, force, acceleration, etc. Calibration may be either by constant-current or constant-voltage method in which a factor of millivolts per volt of bridge voltage is obtained. Accuracy of measurement 0.1 percent.—*Allegany Instrument Co., 1000 Oldtown Road, Cumberland, Md.*



For more information circle **284** on inquiry card.

Hardness-test Kit

New "portable hardness testing lab" weighs less than 15 lbs.; includes two 7-oz. instruments: (1) for testing steel in hard range, with both Rockwell C and Brinell 3000-kg. equivalents; (2) non-ferrous, with Rockwell B and 500-kg. Brinell scales. All hardness values are read directly; no conversions needed. Light-weight anvil is used for supporting small speci-

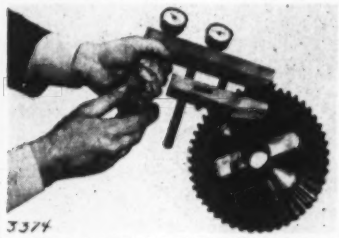


ments and laboratory test blocks. No parts are too large to check with these instruments.—*Peabody Industrial Co., 2832 E. Gd. Blvd., Detroit, Mich.*

For more information circle **285** on inquiry card.

Portable Hardness Testers

New portable hardness testers for laboratory and production testing can test both inside and outside surfaces, are available in two sizes: "Model PHT-1" tests specimens up to 4½

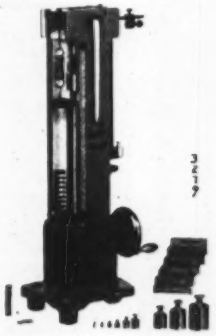


in. diam.; "Model PHT-2" to 12 in. Testers simply clamp onto specimens; employ standard Rockwell indentor and loadings, Rockwell scales A, B, C, D, F, and G.—*Riehle Testing Machines, Div. American Machine & Metals, Inc., East Moline, Ill.*

For more information circle **286** on inquiry card.

Small Spring Tester

Newly redesigned instrument is for testing small compression and extension springs for loads and deflections. General-purpose or occasional testing

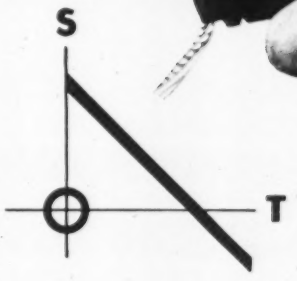


and high-quantity production testing can be done by setting tolerance markers and automatic stops. Capacity 1/64 oz. to 12½ lbs.—*Carlson Co., 277 Broadway, New York 7, N. Y.*

For more information circle **287** on inquiry card.

Pulley Tester

New type of machine tests all commonly-used sizes of pulleys under various selected loads. A 3-hp. vari-drive



USE New DIEHL

INSTRUMENT SERVO MOTORS

Designed for use on recording instruments where rapid acceleration and deceleration are of primary importance.

DIEHL Instrument Servo Motors feature a novel construction with an integrally molded stator and housing. Liberal design characteristics are built-in so that long life can be expected even under severe ambient temperature conditions.

While intended primarily for commercial use, these Servo motors meet pertinent JAN specifications for resistance to humidity, salt spray, fungus, shock and vibration.

SPECIFICATIONS	DIEHL NUMBER	
	FPE21L-27-1	FPE25L-92-1
Output (Watts)	1	5
Frequency (Cycles)	60	60
Poles	2	2
Reference Phase (Volts)	115	115
Control Phase (Volts)	50	115
Reference Phase (Watts)	10	17
Control Phase (Watts)	3.5	17
Control Phase Impedance (Ohms)	555	575
Locked Torque (Oz.-In.)	1.5	5.5
Theoretical Acceleration (Rad/sec.2)	9650	19000

Our engineering staff will gladly help you select the motors best suited to your specific requirements. A request on your letterhead will bring you a copy of Technical Manual No. IN -1154 describing Diehl Servo Motors and related equipment.

Other Available Components:
D.C. SERVO SETS • RESOLVERS
MINIATURE PERMANENT MAGNET D.C. MOTORS

Diehl
DIEHL MANUFACTURING COMPANY
Electrical Division of THE SINGER MANUFACTURING CO.
Finderne Plant, SOMERVILLE, N. J.

For more information circle **69** on inquiry card.

EASY to USE AS YOUR DESK LIGHT

DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

Always a Sharp Picture at the FLIP of a SWITCH

Press operator SEES scrap he just baled being loaded into gondola outside building.

Operators don't have to do any tuning, adjusting or "fiddling" with the Diamond "Utiliscope". Once installed and adjusted, it stays tuned . . . always gives a sharp picture that stays sharp when you flip the switch.

Rugged too . . . it can stand rough handling, dirt, heat, vibration and neglect. Installations in steel mills, power plants, arsenals, railroad yards, automobile plants, etc. have proved that.

Have you an operation that needs to be watched but which is too expensive, remote, inaccessible, or dangerous to observe directly? Send for the new "Utiliscope" Bulletin No. 1136. Use the coupon now.

6945 "Utiliscope" Camera

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

Name_____

Company_____

Address_____

IN

DIAMOND POWER SPECIALTY CORP.

FIRST IN INDUSTRIAL TELEVISION

LANCASTER, OHIO

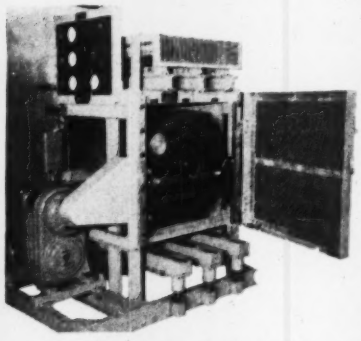
OFFICES IN 39 PRINCIPAL CITIES

Diamond Specialty Limited — Windsor, Ontario

Since 1903, Diamond has Manufactured Quality Equipment for Industry

For more information circle **70** on inquiry card.

NEW INSTRUMENTS

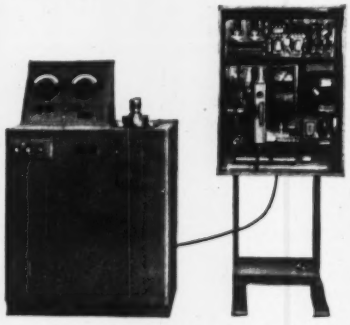


motor, operating from 260 to 780 rpm., drives a Scotch crosshead mechanism which, through a system of cabling, keeps pulleys under test in constant motion. Equipped with an oven, machine is capable of testing 12 pulleys simultaneously, two of them at temperatures up to 800 F. Height 7 ft., width 8 ft. 8 in.—*Asch Equipment Co., 642 Keowee St., Dayton 4, Ohio.*

For more information circle **288** on inquiry card.

Balancing Machine

New Vertical Static Balancing Machine checks up to 240 or more parts per hour; operates on "go-no go"

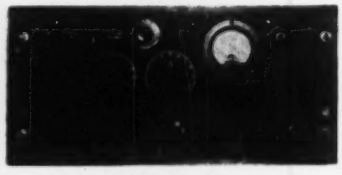


principle. Signal lights are controlled by a separate unit which can be set for any desired tolerance of unbalance. Machine can also be operated as a standard static balancing machine.—*Tinius Olsen Testing Machine Co., Balancing Dep't, 4059 Easton Road, Willow Grove, Pa.*

For more information circle **289** on inquiry card.

ELECTRICAL TESTING
Voltage Coefficient Test Set

New test set provides a rapid and reliable measurement of voltage coefficient for composition resistors; is useful in study of resistor materials and geometry, contact behavior, and semiconductor phenomena; can be used for inspection and quality con-



RELIABLE AND STABLE PERFORMANCE

•

servo components, instruments, synchros

Let us quote on your detailed requirements.

American Electronic Mfg., Inc.

9503 W. JEFFERSON BLVD., CULVER CITY, CALIF.

TELEPHONE: TExas 0-5471

For more information circle **71** on inquiry card.

trol of components. Operating principle: non-ohmic nature of a material or resistor (i.e., voltage coefficient), will result in generation of current harmonics when an alternating voltage is applied. Temperature nonlinearities are thus separated from voltage nonlinearities and component can be tested up to rated power dissipation conditions, if desired.—*Brunswick Instruments, P. O. Box* 813, *New Brunswick, N. J.*

For more information circle **290** on inquiry card.

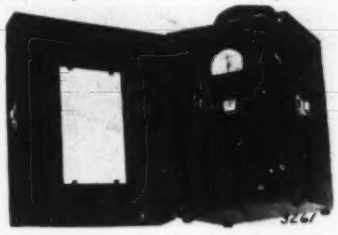
Thermostated Jig for Breakdown Testing

New oven testing jib meets ASTM D-69-48T, ASTM D-119-48T or MIL-I-7798; is for use with "Model PA-5 Breakdown Tester" for high-voltage testing of electrical tapes, insulation and dielectrics at temperatures from room to 200° F. (higher temperature ranges on special order). Interlocking switches give complete safety for operating personnel.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **291** on inquiry card.

Earth Resistivity Tester

New "Model 274 Vibroground" permits exploration of the earth's substrata by electrical resistivity meth-



ods to greater depths than heretofore possible with a small self-contained instrument. It uses four-electrode a-c. fall-of-potential method and reads resistance directly on a large dial-type potentiometer calibrated to accuracy of 1 percent of full scale.—*Associated Research, Inc., 3766 W. Belmont Ave., Chicago, Ill.*

For more information circle **292** on inquiry card.

ELECTRICAL INSTRUMENTS

Electrometer

New low-cost electrometer is basically a d-c. vacuum-tube type micromicroammeter whose current-measuring range is from 10^{-12} to 10^{-3}. Weight 4½ or 6 lbs. (battery- or line-operated model). Scale divisions 0 to 1 with subdivisions 0.2, 0.4, 0.6 and 0.8. Thus, readings become simple multiplication (reading times range-switch setting). Other controls are a calibration button and a zero-set knob. Test leads are affixed to two of three posts, middle post being a common ground. Among uses: measuring insulation and capacitor current leakages; currents in circuits employ-

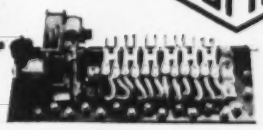
Here are 3 PROVEN ANSWERS to your timing problems

1

AEMCO AUTOMATIC RESET TIMER

Opens or closes circuits for intervals of seconds or hours, recycling immediately or holding a circuit for a fixed interval before recycling. Stock models available with fixed or adjustable settings. In case of current interruption unit will recycle or hold position and recycle with return of current.

2



AEMCO SEQUENCE TIMER

Engineered to meet requirements for the individual timing of a series of operations. All circuits are 15 amp., have positive quick make and break pure silver contacts. Friction clutch between cam shaft and motor gear train may be manually adjusted at any time desired. Automatic Sequence Timers may be supplied in SPST or SPDT . . . are carefully engineered to meet exacting specifications.

3

AEMCO CYCLE MASTER

This low-cost Automatic Time Switch can be set for as many as 48 ON and OFF operations per revolution of the dial. Unit has a 15 minute minimum ON or OFF interval on 24 hour cycle unit . . . 7½ minute interval on 12 hour cycle models and as little as 37½ second intervals on 1 hour cycling models. All models will control up to 48 ON and OFF operations during cycle. Available with Sunday and holiday cutout in 10 or 20 amp. capacity . . . four to eight terminal panel.

AEMCO ENGINEERED RELAYS

AEMCO also manufactures a complete line of quality relays . . . open and sealed type, midgets and miniatures . . . plug-in base or specialized mountings . . . an almost limitless variety of spring and coil combinations. AEMCO Relays exceed specs . . . *military or industrial!* Specialized units engineered and manufactured to meet particular requirements and specifications.

Why not write us today? The services of our skilled engineering staff are at your disposal.

AEMCO Automatic Electric MFG. CO.

58 STATE STREET · MANKATO, MINN.

For more information circle **72** on inquiry card.

ing semi-conductors; ion-chamber, photocell and vacuum type grid currents; currents in mass spectrometers; etc.—*Electro Nuclear Corp., Harvey Building, West Palm Beach, Florida.*

For more information circle **293** on inquiry card.

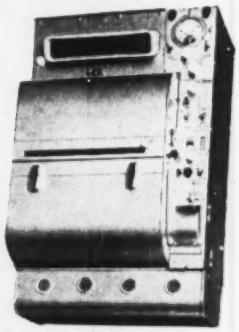
Six-channel 'Scope

New "Model H-62," for automatic analysis of dynamic stress and strain, is basically a six-channel oscilloscope; can display simultaneously up to six stresses or strains on face of a single CRT. Pickups may be either strain-gage type or high-impedance piezoelectric, etc. Unique feature is novel sequence timer: after set-up it reduces operation to push-button automation. Amplifiers are d-c. coupled, balanced; provide for either single-ended or differential input; are equipped with adjustments for drift correction, internal gain, and balance. Band width is from d.c. to 200 kc. down 30 percent. Maximum gain is adjustable to 500 microvolts/inch. A step attenuator provides 36 db of attenuation in 6-db steps.—*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **294** on inquiry card.

Multichannel Oscillograph

New "700C" for dynamic data recording is available in two models; "708C" which records up to 36 channels on 8-in. media; "712C" which provides up to 60 channels using 12-in.



media. Record speeds from 0.03 ips. to 144 ips. availabe through rapid change gears. Any one of four record speeds (with automatic recording intensity control) may be selected from operating panel while a record is in progress. This permits "jump speeds" having 2:1, 4:1, and 8:1 ranges. New optical system provides ample intensity for highest writing speeds. Provision is made for operation of same instrument from 28 v.dc., 115-v. 60-cps., or 115-v. 400-cps.—*Heiland Div., Minneapolis-Honeywell, 130 East Fifth Ave., Denver, Colo.*

For more information circle **295** on inquiry card.

Viking miniature connectors

DESIGNED FOR LONG RELIABLE SERVICE LIFE

VIKING circular types. Positive polarization and shielding. Simple locking device mates units against vibration. One to four contacts on small units—5 to 9 on large units.

VIKING printed circuit receptacle. Increases your circuits—unit shown has 20 contacts, and is interchangeable with 18-contact types. Extremely strong contacts, pierced or unpierced.

Hermetic sealing is available on the circular and rectangular series. Write for literature on these or the complete line of VIKING connectors.

VIKING ELECTRIC

1061 INGRAHAM STREET

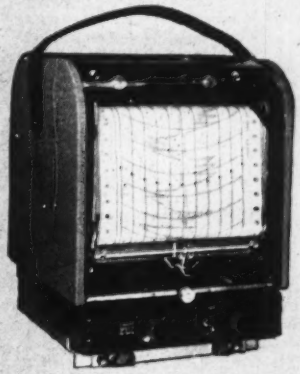
LOS ANGELES 27, CALIF.

For more information circle **73** on inquiry card.

HARD WORK WANTED!

magnetic fluid clutch recording milliammeter

If *you* must make SENSITIVE RECORDINGS under ADVERSE CONDITIONS, the Texas Instruments field-proven Dual Recording Milliammeter was designed with you in mind. It is a durable, ink-writing, accurate recorder with two independent channels and four selective chart speeds . . . all in a 15½ lb, portable instrument.



MAGNETIC FLUID CLUTCH meter movements make possible a sensitivity of 0.45 inch per 100 microamps combined with adherence to rigid military aircraft requirements for shock, vibration, explosion, and humidity resistance. High resultant torque permits the startling reduction in recorder size and weight and creates a new degree of independence from shock, vibration and pen drag.

write today for bulletin DL-C 4001

TEXAS INSTRUMENTS INCORPORATED

6000 LEMMON AVE. DALLAS 9, TEXAS

For more information circle **74** on inquiry card.

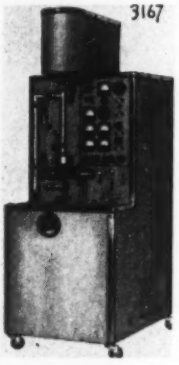
CR Oscillograph

New "CR-1" cathode-ray oscillograph provides continuous, time-synchronized records of up to 16 separate phenomena at frequencies as great as

50,000 cps. All channels are recorded simultaneously on 8-in.-wide photographic paper at chart speeds of 3 to 400 ips. By means of integral single-sweep circuits, instrument's eight dual-gun c-r. tubes may also be directly photographed to provide simultaneous record of 16 phenomena at frequencies as high as 250,000 cps. —*Wm. Miller Instruments, Inc.*, 325 *N. Halstead Ave., Pasadena* 8, *Calif.*

For more information circle **296** on inquiry card.

High-speed Oscillograph

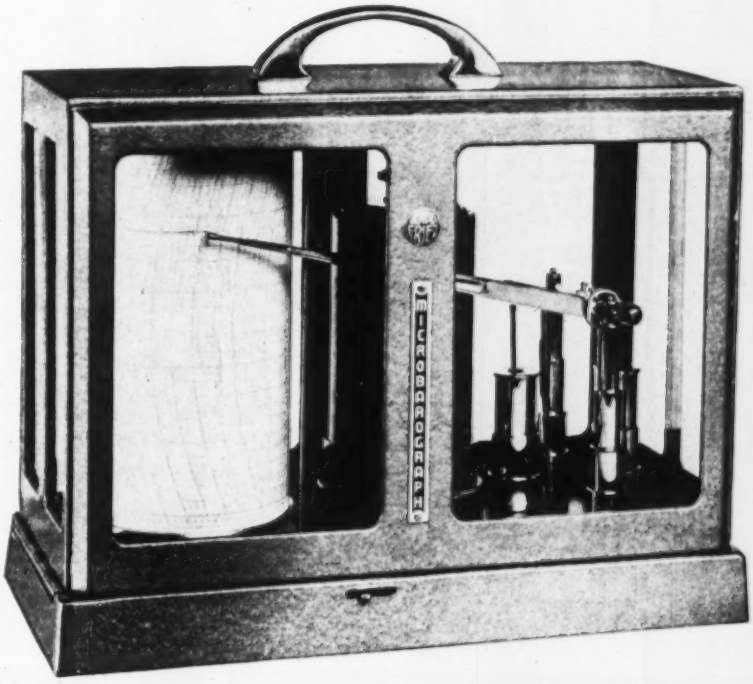


New "Model 2 High-speed Microoscillograph" features proportionally higher cut-off frequency for a traveling-wave deflection system, through micro-electron-optical technique; is suitable for single-sweep recording of three simultaneous phenomena at frequencies up to 10,000 Mc.; yields detailed information on phenomena occurring in time intervals of 0.01 to 0.0001 usec. Electron beams are focused to writing spots of 0.01-mm. diameter by an electromagnetic lens in which coil current is regulated to better than 0.05 percent. Oscillograms are thus reduced in size by a factor of 100 compared to normal-size records with a trace width of 1 mm. Plate dimensions permit 27 oscillograms on a single plate with no overlapping, and enlargements up to 100 diameters.—*Dep't KP, Central Research Laboratories, Inc., Red Wing, Minn.*

For more information circle **297** on inquiry card.

Ground Detector-alarm

New "Brunt Ground Detector and Alarm" warns of accidental grounds as soon as they occur on power lines. When this happens: (1) One of instrument's three phase indicator lights dims or goes out and the other two brighten; (2) simultaneously, red warning light flashes steadily at about 20 times a minute and a relay actu-



MICROBAROGRAPH

BY

Bendix - Friez

RECORDS BAROMETRIC PRESSURES MAGNIFIED 2½ TIMES

What's the pressure been? What is it now? What is the trend?

The whole story is inked for all to see . . . right on the chart of the Bendix*-Friez Microbarograph. Here clearly and precisely are shown the highs and the lows of pressure which pass the area . . . these control our weather.

Producing, as it does, an expanded graph of atmospheric pressure, it registers minute changes on a scale of two and one-half inches of chart to one inch of mercury.

Thus, the Microbarograph finds favor with the hurried forecaster . . . the lines are so crisp and clean and so easy to read.

The research meteorologist refers to the Microbarograph reference charts as of valuable assistance in compiling means and extremes of weather gone by.

To order, ask for model #790. Specify approximate elevation above sea level. Recording periods daily, 4-day or weekly.

Please specify which you prefer.

*Reg. U. S. Pat. Off.

FRIEZ INSTRUMENT DIVISION OF BENDIX AVIATION CORPORATION

1408 TAYLOR AVENUE • BALTIMORE 4, MARYLAND

Export Sales: Bendix International Division, 205 E. 42 St., N. Y. 17, N. Y., U. S. A.

For more information circle 78 on inquiry card.

MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED

STANDARD

MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only* — normally open or normally closed.

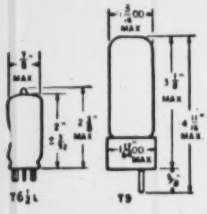
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

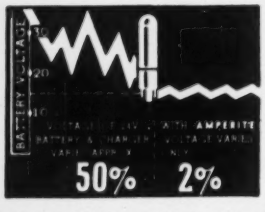
TYPES: Standard Radio Octal, and 9-Pin Miniature.

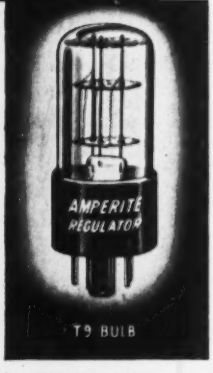
PROBLEM? Send for Bulletin No. TR-81

BALLAST-REGULATORS

- **Amperite Regulators are designed to keep the current in a circuit *automatically regulated* at a definite value (for example, 0.5 amp).**
- **For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., Pulsating Current.***
- **Hermetically sealed, light, compact, and most inexpensive.**







T9 BULB

Maximum Wattage Dissipation: T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining *automatic regulation* of current or voltage. *Hermetically sealed,* they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp. Ltd. 560 King St. W. Toronto 2B

For more information circle **76** on inquiry card.

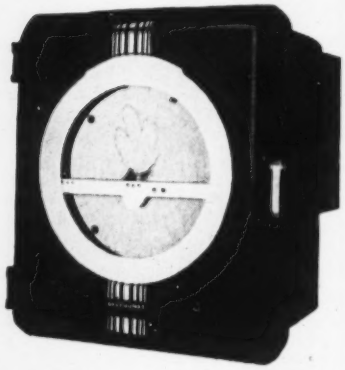
NEW INSTRUMENTS

ates a bell or horn; (3) these signals continue until someone pushes reset button; then (4) audible signal is stilled and red warning light changes from flashing to steady remaining lit until ground is cleared. (5) After the ground is cleared, red light goes out and three phase indicator lights will resume their normal brightness.—*Parr Mfg. Corp., 44 Austin St., Newark 5, N. J.*

For more information circle **298** on inquiry card.

Polar Recorder

New "Speedomax Polar Recorder" automatically plots input as a function of angular displacement. Pen can

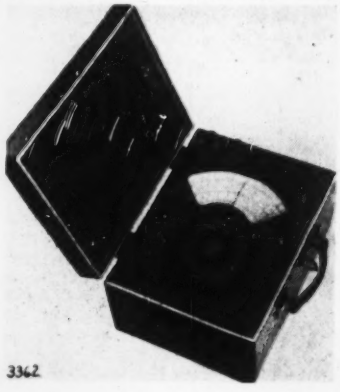


travel across 5-in. radius in less than 2 seconds. As antenna (or other element) is rotated, balancing motor rotates chart in step: positional accuracy better than ¾ of a degree; maximum speed 60 deg. per second.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Penna.*

For more information circle **299** on inquiry card.

Circuit Analyzer

New "Multirange Power Meter" for industrial service (first of its kind to appear in U. S.; Swiss-made) measures alternating voltages up to 600,



3362

a.c. to 1500 amps., active and reactive power up to 900 kw., power factor, and frequency from 40 to 60 cps. Accuracy is 1.5 percent on all ranges. Instrument weighs 13 lbs.; comes in oak carrying case.—*Physics Research Laboratories, Inc., 507 Hempstead Turnpike, West Hempstead, N. Y.*

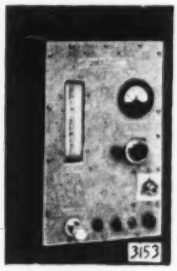
For more information circle **300** on inquiry card.

Extended-range Recorder

New design of maker's "ElectroniK" strip chart recorder couples a single scale with automatic range extension, extending measuring range by five equal suppression steps. Minimum span is 2.2 millivolts. Four additional 2-mv. suppression steps are automatically switched into or out of measuring circuit to meet varying requirements. Thus, a total minimum range of 10.2 mv. is provided.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **301** on inquiry card.

Calorimetric Wattmeter



New "Model L-20" gives better than 5 percent accuracy in power measurements from 10 mw. to 10 watts over whole frequency range from dc. to 10 kMc. Input vswr. less than 1.1 full range; response time less than 1 minute at 10 mw. or 5 seconds at 10 watts. True average power is indicated, regardless of type of modulation.—*Alto Scientific Co., 3404 Cowper St., Palo Alto, Calif.*

For more information circle **302** on inquiry card.

Hook-on Volt-ammeter

New "AK-4" wide-range pocket-size 60-cps. a-c. volt-ammeter includes 150/300/750 volt ranges and 10/30/-

100/300/800 amperes ranges with automatic scale change; also pointer stop mechanism. Safety voltage leads are connected into recessed terminals for protection of operator.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

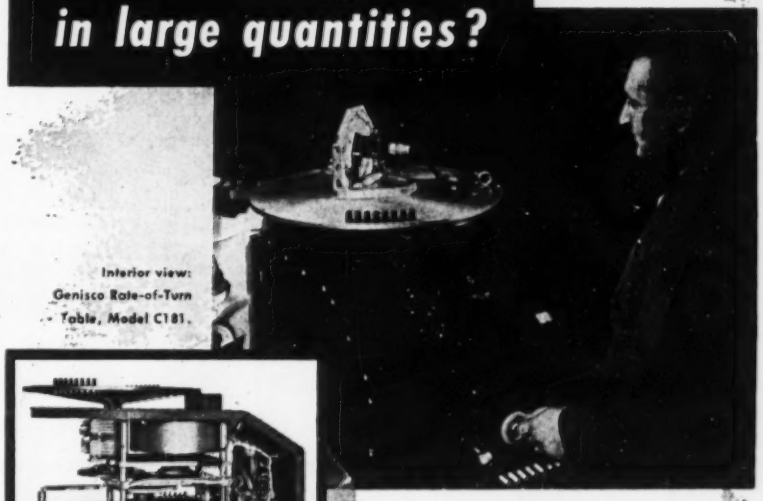
For more information circle **303** on inquiry card.

Frequency Meter

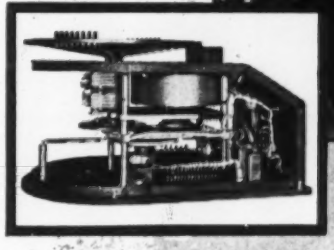
New "Type 410A Direct-Reading Frequency Meter" features a resonant cavity of high *Q* that provides convenience of direct reading with precision, and economy of full waveguide

Is your problem

precision calibration of rate gyros *in large quantities?*



Interior view: Genisco Rate-of-Turn Table, Model C181.



These features assure fast, accurate test data!

- Infinitely variable table speed from 0.01° to 1200° per second.
- Constancy of angular velocity within 0.1%, including wow and drift, at any rate setting.
- Special ball-disc integrator drive eliminates backlash and minute rotational irregularities.
- Unique, synchronous motor has large diameter rotor with high polar inertia; gives extremely smooth operation at all table rates.
- Up to 8 instruments (total weight 100 lbs.) can be tested simultaneously without affecting accuracy.
- Electrodynamic braking permits quick adjustments to instruments being tested.
- Repeat accuracies within 0.2% same direction; 0.5% opposite direction.
- Simple controls enable inexperienced operator to become proficient in a few minutes!
- Large expanded scale is easily read; reduces operator error.
- Noise levels below 2 millivolts per slip ring.
- Reversing operation completed automatically in 20 seconds.
- Machine may be inclined up to 35° to compensate for earth's latitude at testing site.

Read how Genisco Rate-of-Turn Tables are solving the problem for American Gyro Corporation

American Gyro designs and manufactures rate gyros for use in guided missile control systems and high speed jet aircraft. As production of these precision instruments increased, quick, accurate testing of large quantities became a major problem. After an unsuccessful attempt to solve the problem with a custom-made, gear-type machine, they turned to Genisco Rate-of-Turn Tables. The first machine was installed in May, 1953. Its use proved so successful that a second machine was added in November, 1953, as production further increased. Both machines are now operating 18 hours a day, 6 days a week. *In over six months of operation, downtime due to non-routine maintenance has been less than 3 hours on both machines!*

This performance is not unusual!

Most all major gyro manufacturers are using the Genisco Rate-of-Turn Tables with similar results. Its rugged construction, simple foolproof operation, precise repeating accuracy, and versatile mounting facilities were designed specifically for fast, accurate, production-line testing.

If your problem is laboratory or production-line calibration and evaluation of rate gyros *in any quantity*, write for complete data today. Genisco Incorporated, 2233 Federal Avenue, Los Angeles 64, California.

NEW PRECISION STROBE UNIT NOW AVAILABLE!
Provides constant frequency source for monitoring rotation rates; accurate to 0.001%!

Genisco INCORPORATED

For more information circle **77** on inquiry card.

PRECISION

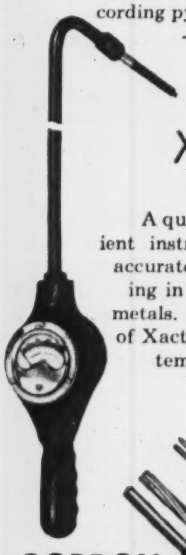
TEMPERATURE

measurement and control

GORDON

XACTLINE

Controls temperature automatically within a fraction of a degree in any heat process. A complete factory-assembled unit ready for installation anywhere. Can be used with any existing indicating or recording pyrometer controller —regardless of age.



GORDON

XACTEMP

Hand Pyrometer

A quality-built, convenient instrument for quick, accurate temperature reading in molten nonferrous metals. Also, other models of Xactemp for all-around temperature checking.

GORDON

SERV-RITE

Thermocouple Wire

Thermocouple Extension Wire

Insulated in Gordon's own plant to assure consistent quality.
All standard wire and insulations carried in stock for quick delivery. Other wires, in long or short runs, manufactured to specifications.

Full Particulars on Request

5148

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers • Engineers • Distributors

Temperature Control Instruments • Thermocouples & Accessories • Industrial Furnaces & Ovens • Metallurgical Testing Machines

Dept. 21 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

For more information circle **78** on inquiry card.

NEW INSTRUMENTS

frequency operation. At room temperature, frequency is indicated to an accuracy of 0.08 percent. *Q* is approx. 10,000 for a frequency meter with 10-kMc. mean frequency. Three models available; from-stock to 3-week delivery.—*Electronics & X-Ray Div. F-R Machine Works, Inc.*, 26-12 *Borough Place, Woodside* 77, *N. Y.*

For more information circle **304** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Frequency Crystal

New "JK-G3" high-stability "Glasline" crystal is smaller than a thumbnail, offers a high *Q* for maximum performance, minimum aging drift; is available in frequency range from 10 to 100 Mc. Vacuum sealing in glass provides protection against shock and contamination and prevents risk of wiring shorts in compact assemblies.—*James Knights Co., Sandwich, Ill.*

For more information circle **305** on inquiry card.

High-voltage Probe

New "Universal High Voltage Probe" permits safe, high-vlotage

measurements up to 30 or 60 kilovolts to be made with any VTVM, multimeter, or voltmeter having 10,000 ohms-per-volt or more.—*Boland & Boyce, Inc.*, 236 *Washington Ave., Belleville* 9, *N. J.*

For more information circle **306** on inquiry card.

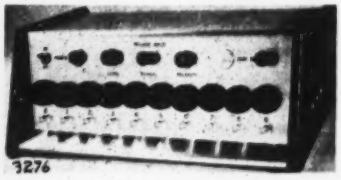
Random Noise Sources

New "Microwave Mega-Nodes" with new gas tubes are added to those which employ fluorescent tubes. New tubes have approx. zero temperature coefficient. Eight sizes, with frequency ranges from 1200-1400-Mc. to 18-26-kMc. Accuracy 0.25 db; noise output 15.8 db.—*Kay Electric Co., Pine Brook, N. J.*

For more information circle **307** on inquiry card.

Ten-channel CRO Switch

New multiplexer enables up to ten synchronized sweeps to be thrown at one time on screen of a single-gun oscilloscope. Basically, it is an ultra-high-speed electronic switch built

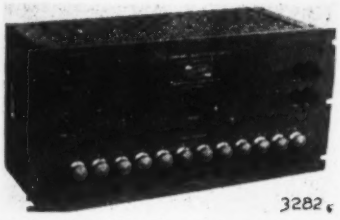


around maker's beam-switching tube. It combines up to ten input waveforms in a single sequenced wave train, then electronically chops train into ten separate sweeps positioned vertically on single-gun 'scope screen. Among uses: (1) strain gage analysis, (2) TV receiver design, (3) medical electronics. Front panel controls for each input amplifier permit user to vary d-c. level of each wave-form and thus position them at will down face of 'scope.—*Electronic Instruments Div., Burroughs Corp.*, 1209 *Vine St., Philadelphia, Pa.*

For more information circle **308** on inquiry card.

Twelve-channel CRO Switch

New "Model 19" 12-channel electronic switch permits displaying 12 separate signals on a conventional single-channel cathode-ray tube, is designed to work into any commercially-available 'scope having provisions for

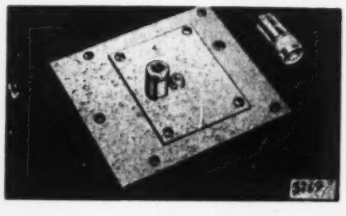


Z-axis blanking. Instrument consists of 12 individual d-c. amplifiers gated sequentially by a ring oscillator. Each gate is open about 25 microseconds at a sampling rate of 2300 cps. Gated amplifiers, being d.c., have a bandpass from d.c. to about 100 kc. Thus, highest frequency which can be displayed is limited only by sampling rate. Each base line may be individually positioned on screen. Instrument operates from 110-v. 60-cps. source. —*Century Geophysical Corp.*, 1333 *North Utica, Tulsa, Okla.*

For more information circle **309** on inquiry card.

Coax Adapter Kit for Impedance Bridge

New "Type 515-A Co-Ax Adapter Kit," when installed on maker's "Type 250-A RX Meter" wide-range VHF impedance bridge, provides a direct

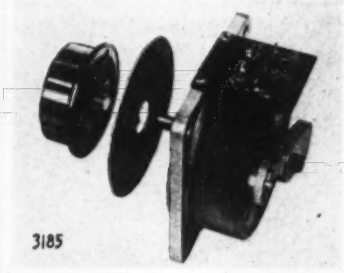


Type N coaxial connection to bridge for continuous operation between 500 kc. and 250 Mc. "Type 516-A Termination Assembly," which is included in kit, is also available separately.—*Boonton Radio Corp., Boonton, N. J.*

For more information circle **310** on inquiry card.

Variable Transformers

New "Types M-2 and M-5 VARIAC" autotransformers meet 350-to-1200-cps. aeronautical and marine requirements; have also been ruggedized un-

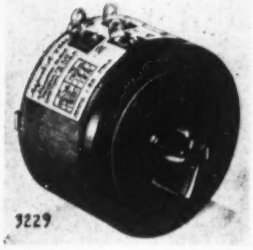


der MIL-T-945-A; are furnished with "Duratrak" contact surface; are rated at 2 and 5 amps. respectively; output range 0-115 or 0-135 volts depending on connections.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **311** on inquiry card.

Variable Transformer

New "Adjust-A-Volt 100BU" variable transformer for 50-100-150-watt loads is easily installed in back-of-panel position; is a toroidally-wound, hydrogen-annealed autotransformer;

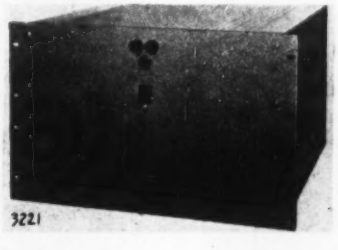


steplessly delivers any output voltage from 0 to above line voltage with no waveform distortion.—*Standard Electrical Products Co., 2240 E. Third Street, Dayton, Ohio.*

For more information circle **312** on inquiry card.

Line-voltage Regulators

New a-c. line voltage regulators, offered in five popular ratings, feature extreme efficiency of self-saturating circuit designed for low output impedance which permits transient overloading without undue loss of regu-



MERIAM MANOMETER ACCURACY

"...important, economical, dependable in dust collection"

Aeroturn Dust Collectors manufactured by Turner and Haws Engineering Co., Inc., West Roxbury, Massachusetts, are equipped with two Meriam Manometers, as illustrated, to indicate pressure.

Each Standard Model of *Aeroturn* Dust Collectors has been equipped with two Meriam Manometers for the past six years. One indicates—in inches of water—the pressure loss of the filter medium. The other—in inches of mercury—indicates output pressure of a positive displacement type of blower. The blower supplies air for an automatic filter cleaning apparatus.

*Meriam Instrument Technical Man

"Meriam Manometers provide an economical, accurate and dependable means of showing pressure information which is of great importance in the operation of our dust collectors," say Turner and Haws Engineering Co., Inc.

If you have a pressure problem call your MIT* Man, or write us. We make instruments that are primary standards for indicating pressure or flow of liquids and gases.

THE MERIAM INSTRUMENT CO. • 10958 MADISON AVE. • CLEVELAND 2, OHIO

Western Division: 4760 E. Olympic Boulevard, Los Angeles 22, Calif.

In Canada: Peacock Bros., Ltd., Montreal

MERIAM Instruments

ESTABLISHED 1911

MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

For more information circle **79** on inquiry card.

.0001"

COORDINATE MEASUREMENTS CAN BE MADE DIRECT ON THE

Gaertner TOOLMAKER'S MICROSCOPE

Using Full 2" Precision Screws

This and the following features make the Toolmakers' Microscope an almost indispensable instrument in your shop or laboratory.

Range 2 x 4 inches
360° Stage Rotation
Reading to 1 minute

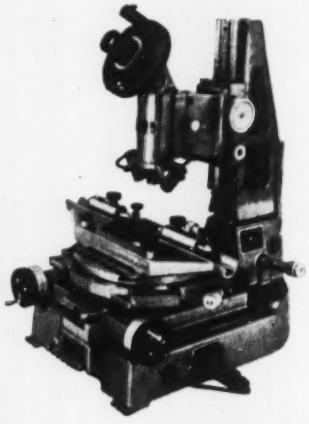
Protractor Circle
Range 360°
Reading to 1 minute

Magnification 30X

Stage Motion
By 2 inches
Precision Screws

Column Tilt 8°
For Helix Measurement

Rugged Construction
for Many Years of
Dependable Accurate Service



For a completely illustrated book listing detailed specifications and accessories request Bulletin 147-50.

THE GAERTNER SCIENTIFIC CORPORATION

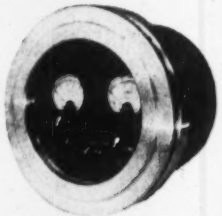
1211 Wrightwood Avenue • Chicago 14, Illinois

For more information circle **80** on inquiry card.

D. C. POWER SUPPLY

EXPLOSION-PROOF—PANEL MOUNTING

The Model 6070 D.C. Power Supply provides a filtered, adjustable D.C. output of 0-30 volts at 5 amperes when used with an I.L.S. Model 6100 explosion-proof Powerstat and isolation step-down transformer. Voltmeter, ammeter, and fuse are provided and all units are removable from the front of the panel.



MODEL 6070

INSTRUMENT *Laboratory* SERVICE

10701 BRIGGS RD. CLEVELAND 11, OHIO

TELEPHONE WINTON 1-5168

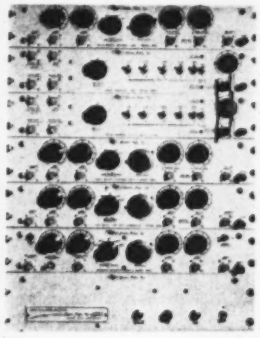
For more information circle **81** on inquiry card.

lation. Control section is basically a magnetic amplifier with a cold-cathode tube voltage reference. An alternate tube is ever-ready as a standby; test switches permit routine checks of both tubes.—*Power Equipment Co., 55 Antionette St., Detroit, Mich.*

For more information circle **313** on inquiry card.

Double Pulse Generator

New "Model 2140A" provides low source impedance, fast rise time, variable separation width, amplitude, and



polarity pulse pairs. All parameters of each pulse are independent and pulses may be superimposed or separated in time. Rise time of either pulse is 0.02 usec. with variable amplitude of either polarity to at least 50 v. from an internal impedance of 50 ohms.—*Electro-Pulse, Inc., 11811 Major St., Culver City, Calif.*

For more information circle **314** on inquiry card.

SSB Filter

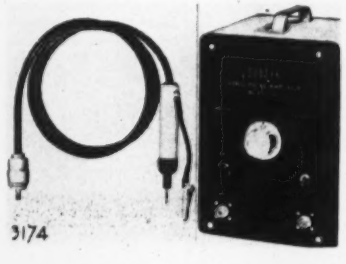
New "S-16000" upper single side band filter (companion to "S-15000") utilizes toroidal coils instead of crystal elements; is fixed-tuned and hermetically-sealed; requires no adjustment. High *Q* characteristics of toroids make it possible to provide a narrow-band, sharp cut-off response which insures maximal intelligibility and maximal signal strength.—*Burnell & Co., Inc., Dept. A1, 45 Warburton Avenue, Yonkers, N. Y.*

For more information circle **315** on inquiry card.

AMPLIFIERS

Measurement Amplifier

New "Model 60 Video Probe Amplifier" facilitates circuit examination with all types of 'scopes without loading, detuning or other adverse effects; 'scopes may be used at full gain for accurate observation of small signals. Amplifier has uniform frequency response from 5 cps. to 12 Mc. within 3 db (equal to or greater than that of



3174

most 'scopes); also serves as general-purpose amplifier with gain of 40X and more than 12 volts peak-to-peak output.—*Donner Scientific Co., 2829 7th St., Berkeley 10, Calif.*

For more information circle **316** on inquiry card.

D-c. Amplifier

New "Model 220" has frequency response from d.c. to 20 kc; is for use with cathode-ray oscillographs in strain gage work. Gain 1500. Com-

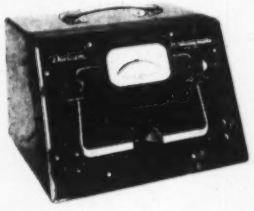
3255

pletely self-contained with its own power unit. Noise level 3½ microvolts rms.—*Allegany Instrument Co., Inc., 1000 Oldtown Rd, Cumberland, Md.*

For more information circle **317** on inquiry card.

Indicating Amplifier

New "Model 2HLA-3" measures d-c. signals as small as 2×10^{-15} watt; utilizes maker's "Second-Harmonic Magnetic Converter" as input stage to avoid limitations of usual vibrator-



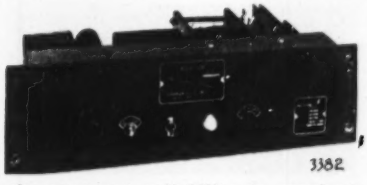
type converters and achieve stability. Frequency response flat to greater than 20 cps. on all five ranges; sufficient power output to drive penmotor or galvanometer recorders. Gain, linearity, and drift are unaffected by variations in line voltage or tube characteristics.—*Doelcam Corp., 1400 Soldiers Field Rd., Boston 35, Mass.*

For more information circle **318** on inquiry card.

POWER SUPPLIES

Mag-amp-reg. Supply

New "Model MA65" magnetic amplifier d-c. supply is designed for telephone and telegraph systems, etc.,



3382

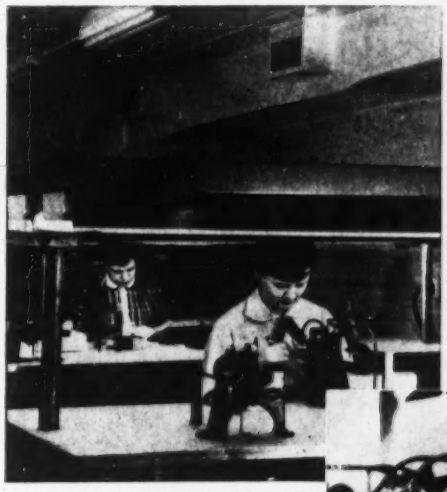
where utmost reliability is required. Input 105-125 vac., single phase, 60 cps.; output 6 vdc., adjustable plus

A NEW more reliable air conditioning method

with exact moisture control

FOR YOUR PROCESS OR PROTECTION

FOR TESTING PRODUCTS OR MATERIALS AT ANY TIME OF THE YEAR



ASSEMBLING ELECTRONIC PARTS

PACKAGING FOOD PRODUCTS

● This Niagara "Controlled Humidity" method gives you the **MOST EFFECTIVE** Air Conditioning because its cooling and heating functions are made completely separate from adding or taking away moisture. This assures you always a precise result. No moisture sensitive instruments are needed.

MOST FLEXIBLE. You can reach and hold any condition in response to instrument settings, or vary it as you wish.

EASIEST TO TAKE CARE OF. The machine is accessible, the control circuits are simple and easy to operate, and there are no solids, salts or solutions to be handled.

MOST COMPACT. It does a very large amount of work in a small space.

INEXPENSIVE TO OPERATE. At normal atmospheric temperatures (unlike systems that use refrigeration to dehumidify) it needs no summer re-heat.

DRYING INDUSTRIAL MATERIAL

Write for Bulletins 112 and 122

NIAGARA BLOWER COMPANY

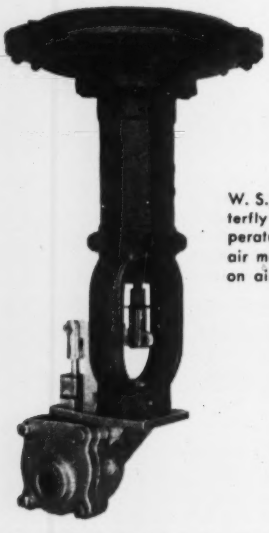
DEPT. IN. 405 LEXINGTON AVE. NEW YORK 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

For more information circle **82** on inquiry card.

VALVES for CONTROLLING FLUID FLOW

W. S. Rockwell double butterfly valve, linked to a single motor operator so that blades oscillate to provide alternate flow from 25% minimum to 75% maximum, in a metered sewage digestion process.



W. S. Rockwell 6" alloy steel butterfly valve to handle high temperature gases; fitted with an air motor and arranged to open on air failure in operator.

W. S. Rockwell proportioning valve for line carrying abrasive-laden fluids; controlled by air diaphragm operator.

W. S. Rockwell "Strate-Line" Flow Valve to provide uniform, positive oil flow directly proportional to the numbers on the calibrated dial.

These are examples of the many butterfly, slide and special valve types, Rockwell-designed and built, for industrial applications. What's your problem?

W. S. ROCKWELL COMPANY

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2644 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities

For more information circle **83** on inquiry card.

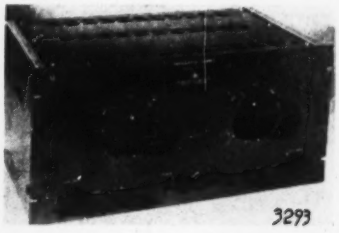
NEW INSTRUMENTS

and minus 10 percent; load range 0-5 amps.; regulation accuracy 1 percent for any combination of line and load conditions.—*Sorensen & Co., Inc.*, 375 *Fairfield Ave., Stamford, Conn.*

For more information circle **319** on inquiry card.

Dual Power Supply

New "Model D3-150-L" is dual version of "Model 3-150-L." Cost is said to be comparable to what customer

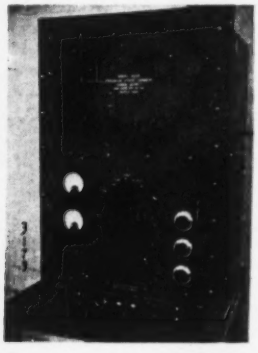


would have to pay if he purchased components separately. Seven different outputs include a completely isolated output from each side, providing each half with an output from zero to 300 v.dc. at 150 ma.; these can be connected to provide twice this voltage. —*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.*

For more information circle **320** on inquiry card.

D-c. Power Supply

New "Model 300R" is described as "a super-regulated ultra-stable d-c. supply capable of delivering 0.3 amp.

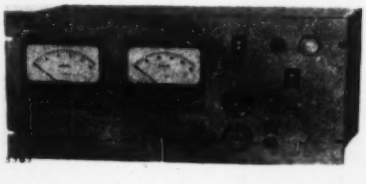


at any output voltage from 0 to 1514 volts." Four decade switches permit selection of output voltage in 1-v. steps; vernier affords resolution of 2 mv. at any output voltage.—*John Fluke Mfg. Co., Inc., 1111 W. Nickerson St., Seattle, Wash.*

For more information circle **321** on inquiry card.

D-c. Power Supplies

New group of power supplies listed as standard sizes and designed for heavier power requirements is offered. New voltage regulating circuit corrects for fluctuations of a-c. input



line voltage as well as variations in d-c. load; does not depend on accurate maintenance of a-c. line frequency. Circuit is of self-saturating type and uses an open bridge or magnetic amplifier bridge selenium rectifier in most sizes. One VR-105 voltage regulating tube as a reference and another VR-105 as standby; transition is smooth and without interruption in d-c. output circuit.—*Power Equipment Co., Detroit, Mich.*

For more information circle **322** on inquiry card.

D-c. Power Supply

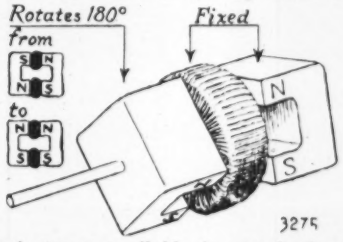
New "Model 2600 Voltage Regulated Power Supply" has continuously-variable 0-50 v.dc. 2-amp. output. Regulation: output voltage variation is less than 5 mv. for line fluctuations from 105 to 125 v. and less than 5 mv. for 0-to-2-amp. load variations. Ripple voltage less than 1 mv. Unit is designed for relay rack mounting or bench use.—*Kepco Labs., 131 Sanford Ave., Flushing 55, N. Y.*

For more information circle **323** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

Variable Inductor

New "Rotoroid" is a hermetically-sealed continuously-variable toroidal inductor, available in any value of

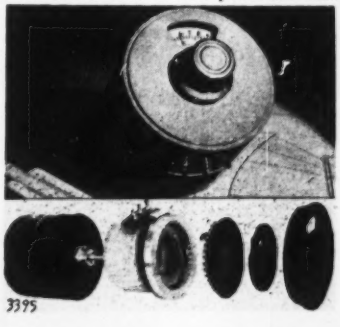


inductance available in standard toroids. It provides a 3:1 range of maximum-to-minimum inductance and, at maximal inductance, provides full *Q* of toroid. Units can be chassis- or panel-mounted.—*Dep't A1, Burnell & Co., Inc., 45 Warburton Ave., Yonkers 2, N. Y.*

For more information circle **324** on inquiry card.

Combination VDR and Autotransformer

New "Vernistat," for use in servo systems and analog computers, is essentially a combination of voltage-dividing resistor and autotransformer, but its principle of operation differs from that of other VDRs and autotransformers. It comprises a tapped autotransformer which provides basic



Circle **84** on inquiry card ⟶

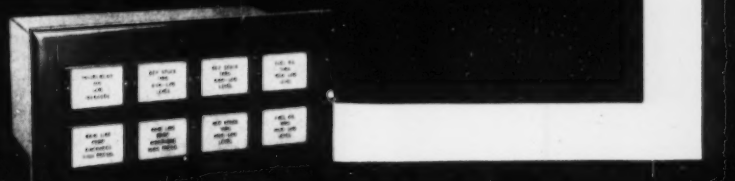
PANALARM "50" ANNUNCIATOR SYSTEMS

NEW functional flexibility with NEW "instrument-type" construction

PANALARM "50" PLUG-IN UNIT . . . hermetically sealed and most versatile ever developed . . . simply plugs into chassis to expand system . . . no wiring . . . no other connections. Corrosion-proof and suitable for Class I, Div. 2 locations.

Built-in flexibility of PANALARM "50" allows simple change-over to any operating sequence as required by present or future conditions. And, at the same time PANALARM "50" introduces a new instrument-type annunciator construction . . . adding to the long-term dependability of the entire system.

CABINET is substantial gauge steel with sturdy chassis and sub-door arrangement. It is pre-wired ready for installation, yet completely flexible without re-wiring.



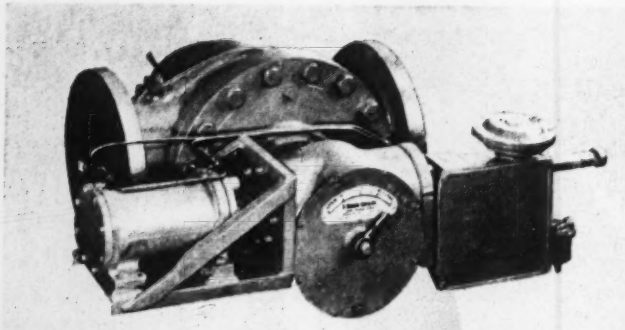
PANALARM ANNUNCIATOR SYSTEMS are self-contained with either illuminated name-plates or bullseye visual signals. Both the audible signal and acknowledgment button are common to the entire system.

SEND FOR COMPLETE 40-PAGE MANUAL

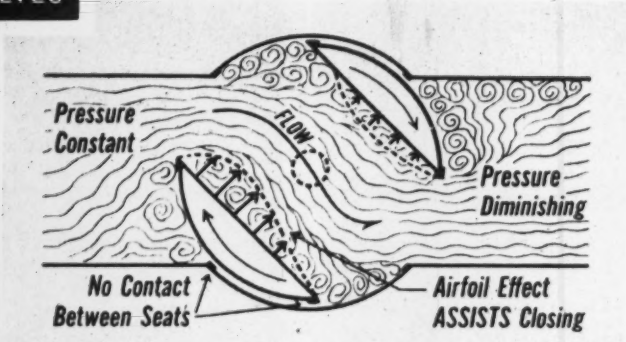
Ask for Catalog 100-1

PANALARM

PANALARM PRODUCTS, INC.
7406 N. Hamlin Ave., Skokie, Illinois



SMS ROTOVALVES



Hydraulic Imbalance Makes SMS-Rotovalves EASY TO OPERATE

SMS-Rotovalves are easier to open and close. As shown above, hydraulic imbalance creates a strong airfoil effect to help ease closing. Regulation can be fast or slow to suit process needs.

SMS-Rotovalves give complete control in all positions of an extremely wide operating range. Turndown is so great that one Rotovalve can often replace two, or three conventional valves. Pumping costs are cut, for a full open Rotovalve has no more pressure drop than an equivalent length of pipe of the same diameter.

S. Morgan Smith offers you complete valve engineering service. For information on our entire line of cone, ball and butterfly valves and their suitability for the varied demands of your control problems, see your local representative, or write to S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines
Pumps
Gates & Hoists
Trash Rakes
Accessories

HYDRODYNAMICS

Rotovalves
Ball Valves
Butterfly Valves
Free-Discharge Valves
Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

For more information circle **85** on inquiry card.

division of voltage into several discrete levels. These levels are selected and further subdivided by a continuous one-turn interpolating VDR.—*Vernistat Div., Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **325** on inquiry card.

Power Transistor

New development-type "HD-197" *p-n-p* power junction transistor, of germanium construction, is capable of half-watt collector dissipation without use of a heat sink. Because of its high current gain, it is suitable for switching circuits, Class B circuits, and servomechanisms.—*CBS Hytron, Danvers, Mass.*

For more information circle **326** on inquiry card.

Thyratron

New "Type AX5727," ruggedized version of maker's standard "2D21," is designed for relay and servo-control applications where reliability and mechanical ruggedness are important: mobile and aircraft, etc. It is inert-gas-filled; has negative control characteristics, high control ratio, low grid-anode capacitance and low grid current.—*Engineering Dep't, Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, L. I., N. Y.*

For more information circle **327** on inquiry card.

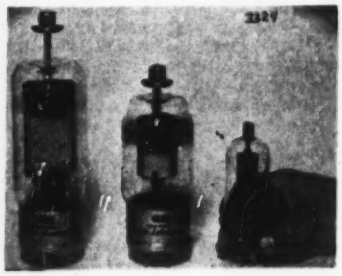
Xenon Thyratron

New "6478" xenon thyratron meets electrical and mechanical requirements for reliable airborne operation at high altitudes; features small size (4⅞ in. long) and flexible anode lead; maximum operating voltage 1500 v.ac.; continuous anode current is 1.5 amps.; continuously-recurring peak anode current 20 amps.; filament current 7 amps. at 2.5 v.; maximum deionization time of 80 usec.; maximum cathode warm-up time 15 sec.—*Taylor Tubes, Inc., 2312 Wabansia Ave., Chicago 47, Ill.*

For more information circle **328** on inquiry card.

Hydrogen Thyratrons

Thirteen new hydrogen thyratron tubes of improved design (mfd by Kuthe Labs.), suitable for industrial and military applications, range from



miniature "Type 1528" rated at a peak output of 10 kw. at an average power level of 25 watts, to giant "Type 1257" rated at 38,000 kw. peak, 45 kw. average. Life of larger tubes extended by internal hydrogen reservoirs.—*Hudson Radio & Television Corp., 48 W. 48th St., New York 36, N. Y.*

For more information circle **329** on inquiry card.

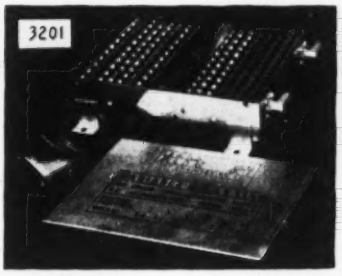
Impulse Generators and Commutators

New "Telepot Microfriction" impulse generators and commutators are of same shape and dimensions as maker's "Telepot Model A" voltage-dividing resistors. Operational life 1 million rotations; maximum operating speed 300 rpm.; contacts made of platinum, nickel, or chrome-nickel. In Impulse Generator, slider makes contact over a drum divided by insulated segments from 1 to 240; slider transmits as many impulses as there are conducting segments. Commutator is composed of 5 conducting and 5 insulated segments; each conducting segment is connected with an exterior lug.—*F. H. Paul & Stein Bros., Inc., 100 Gold St., New York 38, N. Y.*

For more information circle **330** on inquiry card.

Delay Line

New lumped-impedance delay line measures 5½x7½x1½ in.; has a total of 350 sections compactly sandwiched together. Room is provided for miniature six-decade six-position switch. Line has 100 ohms characteristic impedance; total of 3.5 usec. delay. Rise time better than 0.05 usec.—*May Engineering Co., 6055 Lankershim Blvd., North Hollywood, Calif.*



For more information circle **331** on inquiry card.

Delay "Packages"

New "Miniature Plug-In Compound Delay Packages" are announced. Designs already manufactured are distributed-constant lines, used as pulse storage elements in digital computers. (There is no limit to other designs.) Each unit consists of a sealed plug-in brass can with standard Amphenol Type 26 base. Unit #1 contains delay times of 3.65 to 4.25 usec.; unit #2 covers 0.25 to 1.75 usec.; tolerance on any delay is 0.05 usec.—*PCA Electronics Inc., 2180 Colorado Ave., Santa Monica, Calif.*

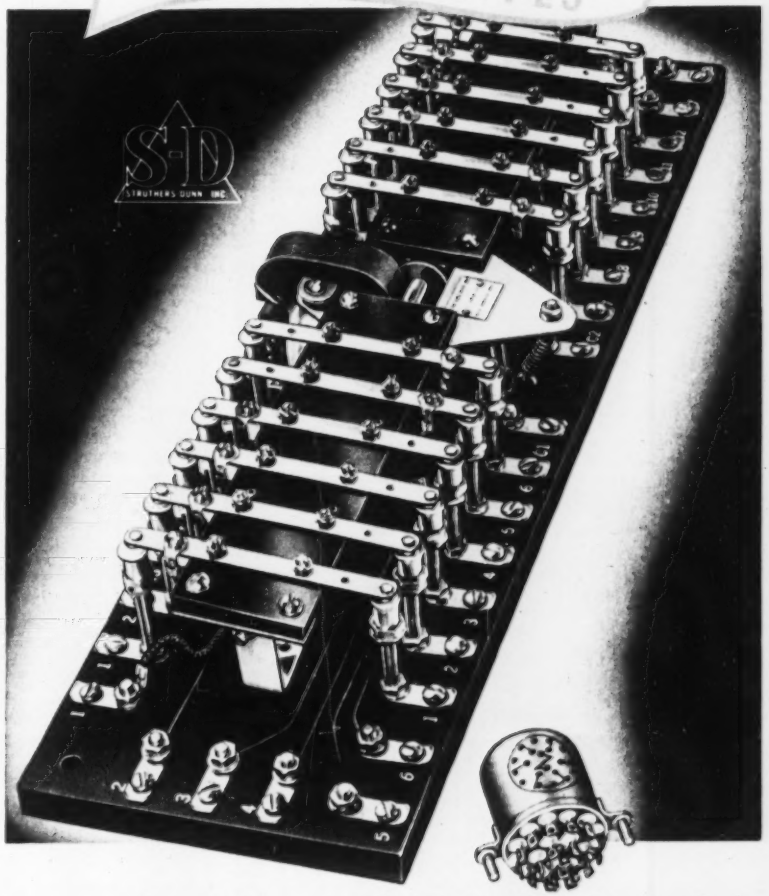
For more information circle **332** on inquiry card.

Variable Delay Line

New "Model V 103-A" provides a variable delay of zero to 3.1 usec., is designed for permanent installation in manufactured equipment; is her-

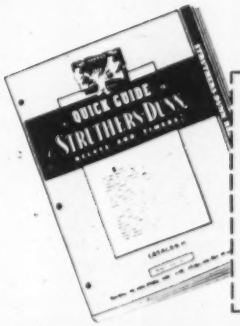
STRUTHERS-DUNN

5,348 RELAY TYPES



. . . from the smallest to the largest
. . . and everything in between!

✓ Industrial ✓ Electronic ✓ Military



QUICK GUIDE . . . to the most popular of the S-D 5,348 relay types.

STRUTHERS-DUNN, Inc.,
Pitman, N. J.

Without obligation send the 20-page "Quick Guide" to S-D relays and timers.

Name

Position

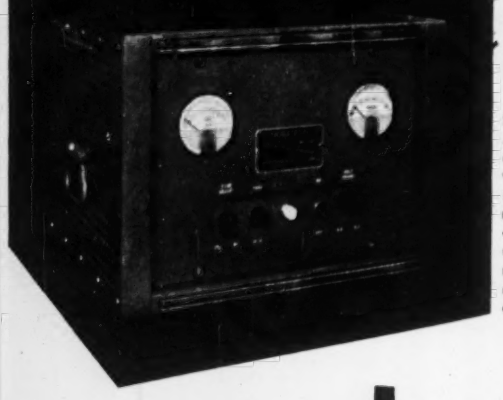
Company

Address

SALES ENGINEERING OFFICES IN: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO CINCINNATI • CLEVELAND • DALLAS • DETROIT • KANSAS CITY • LOS ANGELES • MINNEAPOLIS • MONTREAL NEW ORLEANS • NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

For more information circle **86** on inquiry card.

TUBELESS MAGNETIC AMPLIFIER DC SUPPLIES



Latest additions to the SORENSEN *line!*

Sorensen Tubeless Magnetic Amplifier DC Supplies are designed for applications where utmost reliability is required. The four instruments described below cover a wide range of requirements; additional instruments are under development and will shortly be added to the line.

MODEL MA640 (illustrated above)

Input	105-125 VAC, 1Ø, 60∿
Output	4.5 - 7.7 VDC, adjustable
Load Range	0-40 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.2 seconds under worst conditions
Size	17" wide, 12¼" high, 15" deep Can be furnished for relay rack mounting. Meters, as illustrated, optional at extra cost.

MODEL MA65

Input	105-125 VAC, 1Ø, 60∿
Output	6 VDC, adjustable ±10%
Load Range	0-5 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.15 seconds under worst conditions
Size	For relay rack mounting—19" wide, 5¼" high, 12" deep A cabinet is available for bench operation. This is an unmetered unit.

SPECIAL UNITS

Sorensen is engaged in a heavy program of research and development leading to continuous expansion of its standard line of Magnetic Amplifier DC Supplies. It is accordingly in a favorable position to develop special magnetic amplifier supplies for use in computer systems or other products requiring the utmost in reliability. If you have special requirements along these lines you will benefit by taking advantage of Sorensen's experience in this power field. Write or call the Applications Engineering Department, and your problem will receive prompt attention.

MODEL MA2850

Input	190-230, 3Ø, 4-wire wye, 60∿
Output	23 - 32 VDC, adjustable
Load Range	0-50 amperes
Ripple	3% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.5 seconds under worst conditions
Size	16¾" wide, 28¾" high, 15" deep Unit is self contained and mounted on casters. Meters are standard with this unit.

WRITE FOR MORE DATA

For further information about the Sorensen line of tubeless magnetic DC supplies, and for your copy of the latest Sorensen catalog, write Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe address inquiries to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN
375 FAIRFIELD AVENUE
STAMFORD, CONN.

For more information circle **87** on inquiry card.

NEW INSTRUMENTS

metically sealed with an "O" ring seal for shaft. Delay is obtained with a lumped-constant circuit consisting of 60 coil-and-capacitor sections. A shorting-type rotary switch selects desired delay from 120 steps of 0.025 usec. per step. Over-all accuracy 5 percent. Rise-time from 0.04 to 0.14 usec. according to delay. Nominal impedance 2700 ohms.—*Control Electronics Co., Inc., 1925 New York Ave., Huntington Station, N. Y.*

For more information circle **333** on inquiry card.

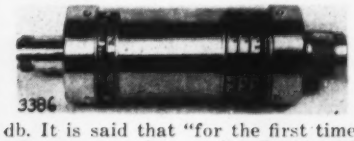
Delay Lines

New encapsulated and open-style lumped-parameter delay lines are for use in TV, as coupling elements for wideband distributed type amplifiers, etc. Typical unit consists of an eight-section low-loss filter having a rise time of 0.04 usec. and delay of 0.3 usec.; maximum pulse voltage 100; impedance 500 ohms; frequency response flat to 8 Mc.—*Shallcross Mfg. Co., Collingdale, Pa.*

For more information circle **334** on inquiry card.

Coaxial Pads

New coaxial pads are designed for a 10-watt input; feature power sensitivity below 0.001 db per db per watt; e.g., a 10-watt input to a 10-db pad changes insertion loss less than 0.1



db. It is said that "for the first time, microwave equipment is offered with accuracies usually found at audio frequencies." New 3- and 10-db pads are within 0.1 db of nominal between d.c. and 1,000 Mc. A calibration, accurate to 0.05 db, is furnished for 400, 750 and 1,000 Mc and to 0.02 db at d.c.—*Weinschel Engineering Co., Inc.*, 10503 *Metropolitan Ave., Kensington, Md.*

For more information circle **335** on inquiry card.

Banked-winding Cores

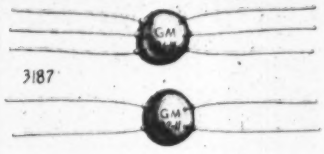
New attachment for automatic toroidal winding machines winds

variable transformer cores with banked windings without using knurled guiding plates.—*Rex Rheostat Co., 3 Foxhurst Rd., Baldwin, L. I., N. Y.*

For more information circle **336** on inquiry card.

Pulse Transformers

New "GM Series" encapsulated miniature toroidal steel core pulse transformers produce rectangular pulses with durations (when operated

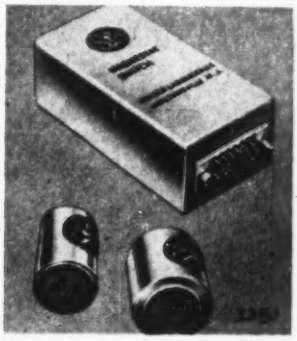


in maker's standard blocking oscillator circuit) of 0.05, 0.1, 0.2, 0.5, 1 and 2 usec. Available with 2 or 3 windings. Will withstand repeated thermal shock cycles from 135 C. to −70 C. and surpass MIL-T-27, Grade 1, Class A specs.—*Gudeman Co., 9200 Exposition Blvd., Los Angeles 24, Calif.*

For more information circle **337** on inquiry card.

Saturable Reactors

New "Magnestats" control pulse or sine-wave power from microwatts to deciwatts at frequencies from 100 kc. to 20 Mc.; are as stable as transformers; do not depend on resonance; both



control and controlled circuits are electrically independent. Units are for use in computers and similar complex systems. For example, "Type AH 25" amplifier operates on 15 Mc. power, will drive two other similar amplifiers with a signal rise time of less than 0.5 usec.—*Snyder Labs., 601 Chapel Ave., Merchantville 10, N. J.*

For more information circle **338** on inquiry card.

Variable Resistors

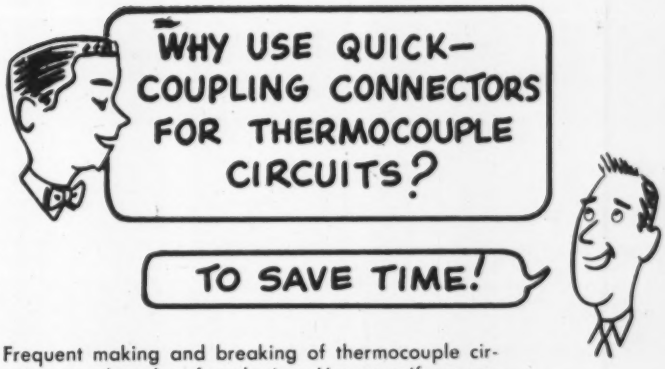
New "Snap-Tite Model 2 Control" eliminates all mounting hardware, twisting of tabs, and mounting tools:

it is pushed into mounting hole where it snaps in place.—*Dep't F19, Centralab Div. Globe-Union Inc., 900 East Keefe Ave., Milwaukee 1, Wis.*

For more information circle **339** on inquiry card.

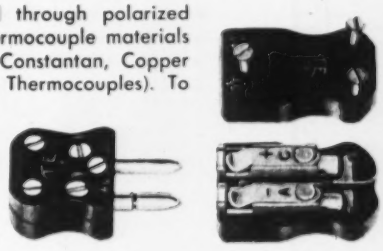
Trimming VDR

New "Model 100 Linear Trimming Potentiometer" is designed for miniaturized equipment where a fully ad-



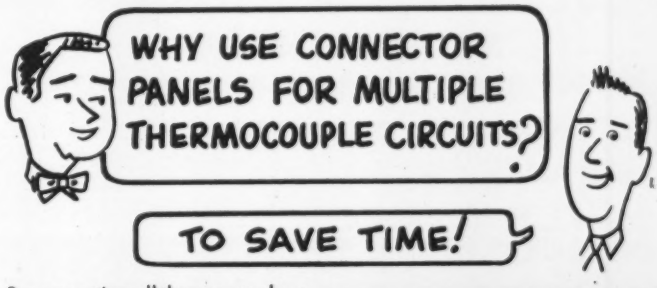
Frequent making and breaking of thermocouple circuits can take a lot of costly time. However, if you use T-E plug-and-jack connectors, a circuit can be made as quickly and easily as plugging in a radio.

Electrical contact is established through polarized elements which are made of thermocouple materials (your choice for use with Iron Constantan, Copper Constantan or Chromel Alumel Thermocouples). To maintain good electrical connection, the mated plug and jack provide both long-wiping surfaces and spring-loaded contacts. The connectors have screw-fastened, insulated covers, colored and marked to indicate calibrations.

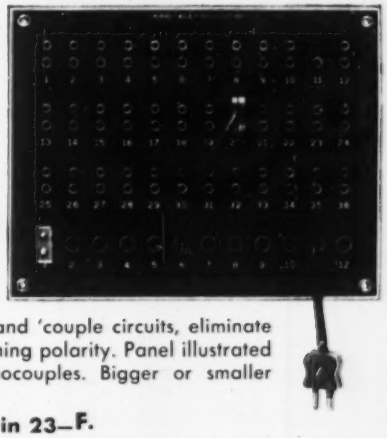


PAT. PEND.

Interested? Write for Bulletin 23—F.



By connecting all thermocouple circuits through central points, such as T-E's connector panels, you can save time in 2 ways. (1) Check instruments or thermocouple circuits from one or more centrally located distribution panels. With plug-and-jack connectors, test instrument is easily and quickly tapped into any circuit. (2) Transfer multiple thermocouple circuits. The panel's quick-coupling connectors permit rapid making and breaking of instrument and 'couple circuits, eliminate splicing time and avoid mis-matching polarity. Panel illustrated takes 12 pyrometers, 36 thermocouples. Bigger or smaller panels, if you want 'em.



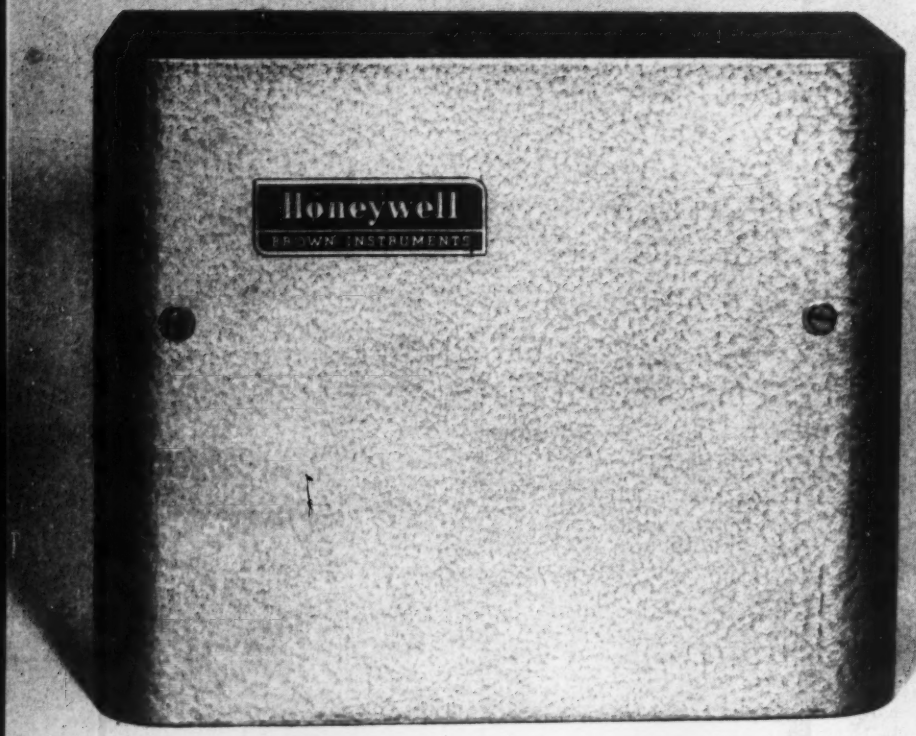
Interested? Write for Bulletin 23—F.

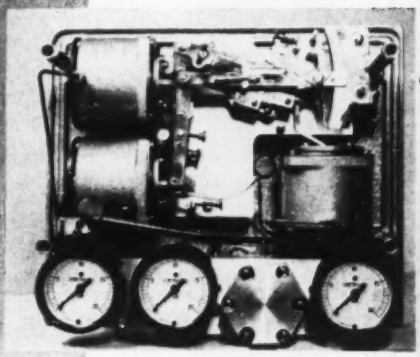
Pyrometers • Thermocouples • Protection Tubes • Quick-Coupling Connectors
Thermocouple and Extension Wires • Resistance Bulbs • Connector Panels

Thermo Electric Co., Inc.

SADDLE RIVER TOWNSHIP, ROCHELLE PARK POST OFFICE, NEW JERSEY
IN CANADA—THERMO ELECTRIC (Canada) Ltd., BRAMPTON, ONTARIO

For more information circle **88** on inquiry card.





Interior view of Ratio Relay shows simple, compact construction. Pressure gages indicate input signals and output pressure. Adjustments for control action, zero setting and ratio range are readily accessible.

The Tel-O-Set Ratio Relay offers these unique features:

★ **LINEAR RATIO**

Output changes in straight-line relation with primary variable. Permits better control tuning . . . eliminates "compromise" settings.

★ **DIRECT OR REVERSE ACTION**

Readily set to provide either increasing or decreasing output . . . increasing or decreasing ratio.

★ **FLEXIBLE ADJUSTMENT**

Ratio range can be reduced to any desired value. Reduced span can be positioned at any desired portion of the maximum range. Factory setting is 50—150% ratio range.

★ **WIDE RANGE**

Ratio can vary from 0 to 200% for a full scale change in the primary variable.

★ **ADJUSTABLE LIMITS**

Readily set stops are provided to limit minimum and maximum output pressure.

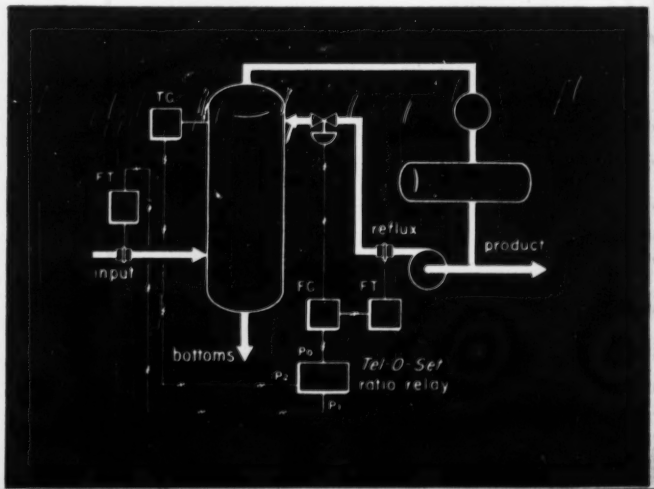
★ **ZERO SUPPRESSION**

Independent zero adjustments permit selection of the exact input-output relationship desired.

★ **INDICATING GAGES**

Separate indicators show output pressure and both input pressures.

On a distillation column, Tel-O-Set Ratio Relay receives air signal (P_2) from column temperature controller. This signal varies the ratio of the output pressure (P_0) to the signal received (P_1) from the input flow transmitter. Output pressure feeds into an *Indexet* remote setting index in the flow controller, to reset this instrument and thus throttle the valve in the reflux line. Ratio of reflux to input is thus varied in accordance with temperature of the top of the column.



For more information circle 89 on inquiry card.

New, versatile means for effecting cascade control

the Tel-O-Set Ratio Relay

HAVE a complex control loop? Here's a versatile way to simplify it . . . the new *Tel-O-Set* Ratio Relay. Another advanced idea in process control from Honeywell, this unique relay proves the ideal solution to complex cascade control problems.

The Ratio Relay provides automatic control with a single element influenced by three interrelated variables. For example, it is used on distillation columns (see diagram) to control the ratio of reflux to feed, as column temperature varies. In absorption towers, it regulates ratio of absorbent and feed stock to give constant concentration of product. And there are scores of other uses for this relay . . . in evaporators, controlled-atmosphere furnaces, reaction tanks, engine testing and other applications where several related variables must be interlocked for efficient operation.

The Ratio Relay receives pneumatic signals from remote transmitters, controllers or manual loading stations. It produces an output air signal for readjusting the set point of a secondary controller. It is the ideal companion for Honeywell Differential Converters, *Tel-O-Set* miniature instruments and Brown pneumatic controllers.

Your nearby Honeywell sales engineer will be glad to discuss applications to your specific process . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Bulletin 9410, "*Tel-O-Set* Ratio Relay."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

For more information circle 89 on inquiry card.

PLATINUM ALLOY
potentiometer windings give
LONGER LIFE and greater

RELIABILITY

in the new *Pacific*
RATE GYRO

Precious metal potentiometer windings, of special platinum alloy, plus Pacific Scientific's advanced production techniques make possible unequaled quality at prices competitive with ordinary designs. Precision potentiometer, new motor and wheel design give maximum dynamic range and exceptionally high natural frequency Powerful signal suitable for either ac or dc intelligence systems. Maximum output up to ±50 volts.

The simple, rugged design of the new Pacific Rate Gyro makes it ideal for checking flight test characteristics, telemetering systems, automatic pilot and guided missile control. Check these specifications against your design problems:

MOTOR POWER—115 volt, 400 cps. or 28 volt d.c., Approx. 10 watts.

RANGE—Any range from ± 10°/sec. to ± 1000°/sec.

NATURAL FREQUENCY—From 3 cps. to 200 cps. depending upon rate range. Example: ± 50°/sec. unit, Natural Frequency—above 25 cps.

DAMPING—Viscous fluid damper, normally 0.5 to 0.7 of critical damping.

POTENTIOMETER RESISTANCE—From 500 ohms to 20,000 ohms, with or without taps, single or dual pots available.

RESOLUTION—0.25% to 0.8% of total potentiometer resistance.

ACCURACY—Within 1.0% to 2.5% of full rate depending upon range of instrument.

PACIFIC SCIENTIFIC—
PIONEERING IN THE FIELD OF AIRCRAFT INSTRUMENTATION SINCE 1919

***Pacific* SCIENTIFIC CO.**

LOS ANGELES, CALIF., 1430 Grande Vista Ave.
SAN FRANCISCO, CALIF., 25 Stillman Street
SEATTLE, WASHINGTON, 421 Michigan Street
ARLINGTON, TEXAS, 111 East Main Street
Eastern Representative. Aero Engineering Inc

For more information circle **90** on inquiry card.

NEW INSTRUMENTS

justable VDR is required; is easily adjusted by screw-driver. Twenty-five turns of exposed adjusting screw cover 90 percent of full range, allowing 18 to 90 deg. of rotation for each electrical increment, depending on total resistance of unit. Small size and method of mounting permit grouping in panel assemblies of twelve units per square inch.—*Ford Engineering Co., Upland, Calif.*

For more information circle **340** on inquiry card.

Deposited-carbon Resistor

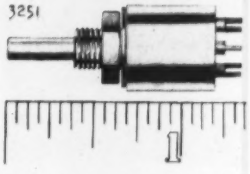
New "Type C5" miniature deposited carbon resistor for transistor and hearing aid circuits is rated at ⅛ watt with a minimum resistance of 5 ohms and a maximum resistance of

0.5 megohm; voltage rating is 150 v.dc.; temperature coefficient negative: –180 to –400 ppm. per C. deg. depending upon resistance value. Unit meets MIL-R-10509A, in addition, resin coats enable it to withstand cycling from –65 C. to 170 C. without damage to coating.—*Mepco, Inc., 37 Abbett Avenue, Morristown, N. J.*

For more information circle **341** on inquiry card.

Subminiature VDR

New "Acepot" is said to represent "a new standard in subminiature wirewound precision potentiometers . . . the smallest on the market with greatest resistance . . . lowest dielectric

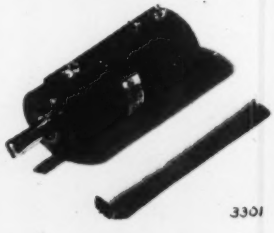


constant and power factor." Available in values from 200 to 50,000 ohms. Independent linearity 0.3 percent standard, lower on special order.—*Ace Electronics Associates, 125 Rogers Ave., Somerville 44, Mass.*

For more information circle **342** on inquiry card.

Ten-turn VDR

New "Type 920" 10-turn voltage-dividing resistor, 1 in. diam. and 2½ in. long, has 26½ in. of coil length enabling maker to guarantee 0.25 percent standard accuracy in resistance range of 4,000 to 200,000 ohms; 0.1 percent accuracy for special applications. Starting torque of 1 oz-in. and



running torque of 0.5 oz-in. enable reducing size requirements of servomechanism equipment.—*Fairchild Camera & Instrument Corp., 225 Park Ave., Hicksville, L. I., N. Y.*

For more information circle **343** on inquiry card.

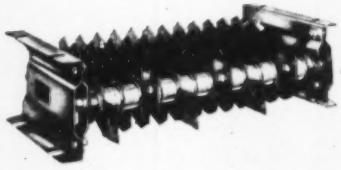
Trimming VDR

New "Carbon Trimpot" provides resistance of 20,000 ohms to 1 megohm and infinite resolution. Announcement states that "Electrical adjustments of infinite accuracy" are easily made by turning slotted shaft with a screwdriver. Self-locking feature eliminates lock-nuts; electrical settings are maintained during extreme conditions of vibration, acceleration and shock. Units may be mounted individually or in stacked assemblies; can be furnished with special features such as dual outputs ("Twinpot"), special resistances and extended shafts.—*Bourns Lab., 6135 Magnolia Ave., Riverside, Calif.*

For more information circle **344** on inquiry card.

Industrial Resistor

New "Bulletin 11011" non-breakable all-welded mill type grid resistor has exclusive "draw-out" feature:

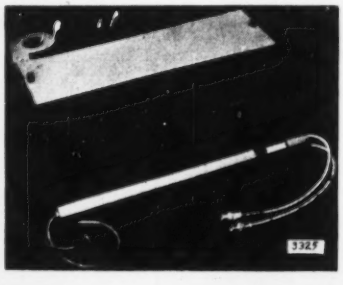


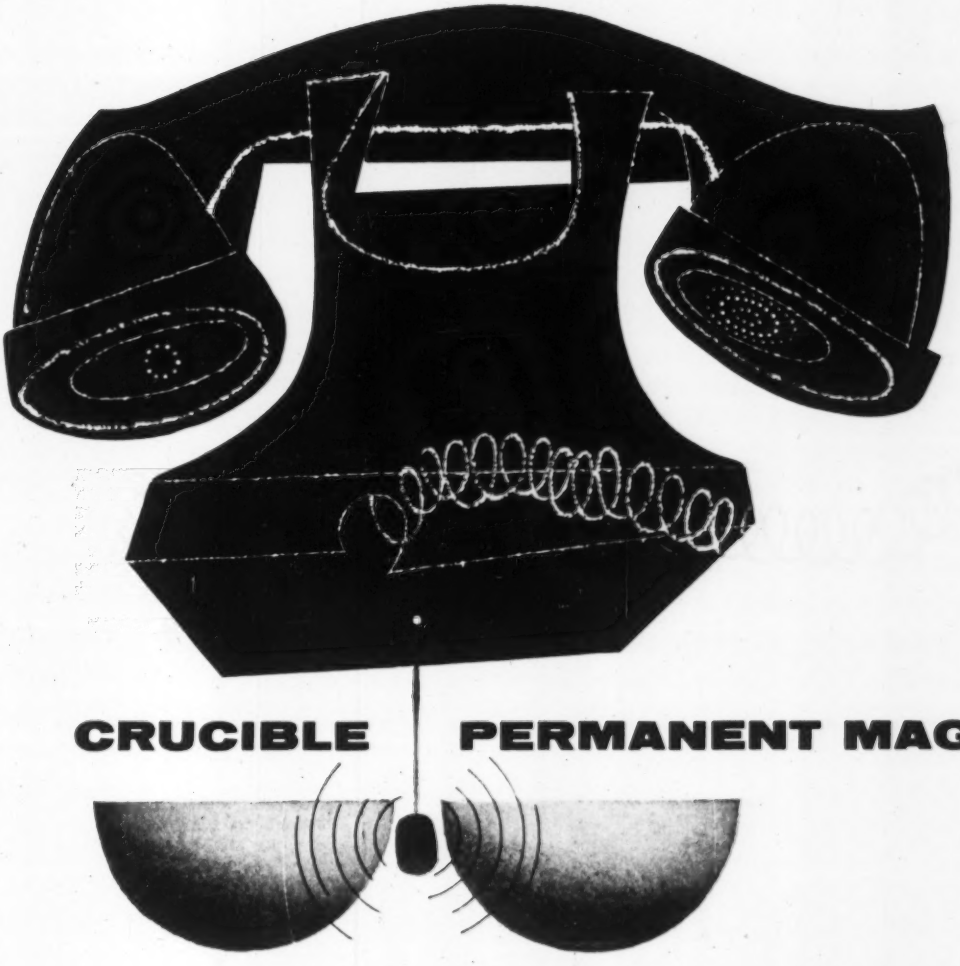
complete grid assembly can be withdrawn from its frame without disturbing grid box end-frames or other boxes in resistor stack. Capacities up to 180 amps per box in ratings from 1/10 to 10 ohms. All grids insulated for 600-v. service—*Cutler-Hammer, Inc., 256 N. 12th Street, Milwaukee, Wis.*

For more information circle **345** on inquiry card.

Traveling-wave-type Amplifier Tube

New "HA-2B" broadband S-band medium-power amplifier, developed to deliver 1-watt output with 1-mw. input from 2 to 4 kMc. without resorting to any electrical or mechanical tuning procedure, finds application in microwave measurement techniques and as a driver amplifier in system applications. With addition of a grid it becomes useful as a medium power





CRUCIBLE PERMANENT MAGNETS

provide maximum energy . . . minimum weight

No matter what your permanent magnet application may be — galvanometer, speedometer, television or telephone — you'll find that Crucible alnico magnets have a *consistently higher* energy product. This means more energy from a smaller magnet.

Since alnico alloys were first developed, Crucible has been a leading producer of this superior type of permanent magnet. And Crucible alnico permanent magnets are made by the nation's foremost specialty steelmaker.

For alnico magnets that are unsurpassed in quality — *call Crucible.*

CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **ALNICO PERMANENT MAGNETS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • ALLOY • MAX-EL • SPECIAL PURPOSE STEELS

For more information circle **91** on inquiry card.

- **RESOLUTION: AS LOW AS 0.25%**
- **POWER RATING: 0.25 WATT AT 100° F.**
- **WEIGHT: ONLY 0.1 OZ.**

BOURNS ***TRIMPOT*** is a 25 turn, fully adjustable wire-wound potentiometer, designed and manufactured exclusively by BOURNS LABORATORIES. This rugged, precision instrument, developed expressly for trimming or balancing electrical circuits in miniaturized equipment, is accepted as a standard component by aircraft and missile manufacturers and major industrial organizations.

Accurate electrical adjustments are easily made by turning the exposed slotted shaft with a screw driver. Self-locking feature of the shaft eliminates awkward lock-nuts. Electrical settings are securely maintained during vibration of 20 G's up to 2,000 cps or sustained acceleration of 100 G's. BOURNS ***TRIMPOTS*** may be mounted individually or in stacked assemblies with two standard screws through the body eyelets. Immediate delivery is available in standard resistance values from 10 ohms to 20,000 ohms. BOURNS ***TRIMPOTS*** can also be furnished with various modifications including dual outputs, special resistances and extended shafts.

BOURNS *also manufactures precision potentiometers to measure Linear Motion; Gage, Absolute, and Differential Pressure and Acceleration*

BOURNS LABORATORIES

6135 MAGNOLIA AVENUE, RIVERSIDE, CALIFORNIA

Technical Bulletin On Request, Dept. 22

© B. L. PATENTS PENDING

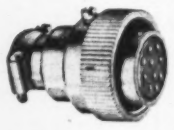
For more information circle **92** on inquiry card.

NEW INSTRUMENTS

modulator. Approx. operating characteristics over this band are 30-db gain, 1-watt output, and 25-db noise figure. It requires a 600-gauss field and a 1200-v. regulated power supply. —*Huggins Laboratories, Inc., 711 Hamilton Ave., Menlo Park, Calif.*

For more information circle **346** on inquiry card.

Miniature Connectors

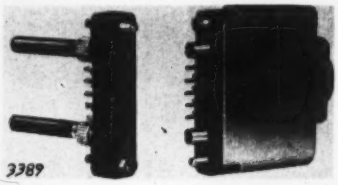


New "K Miniature Series," designed for particular demands of computer field, are adaptable to use in aircraft, electronics, and electrical industries; meet MILE-5272A and MIL-C-5015B. Shell types available include straight, 90-deg. and 45-deg. plugs, all with integral clamps. Standard "KO2" (3102) box mounting receptacle and hermetically-sealed receptacles with steel shells are also available. Construction and design are especially adapted to potting (sealant) techniques.—*Cannon Electric Company, 3209 Humboldt Street, Los Angeles 31, Calif.*

For more information circle **347** on inquiry card.

Miniature Connecter with Two Coaxial Contacts

New "MRX14-2" combines 14 conventional miniature contacts and two general-purpose RF contacts. Coaxial contacts have a nominal impedance of 53 ohms and minimize electrical dis-

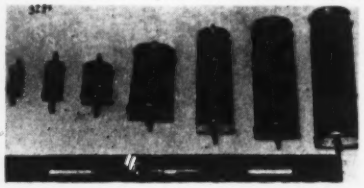


continuity when used with small cables such as RG-58/U or similar. All contacts are rated at 5 amps. and are gold-plated over silver.—*Dept. R, Winchester Electronics, Inc., Norwalk, Conn.*

For more information circle **348** on inquiry card.

Airborne Capacitor

New "Glassmike TSG" capacitor, designed for use in aircraft radio and radar equipment (as well as ground radio and TV transmitters) is said to be also 80 percent smaller than



other capacitors designed for these purposes, because its dielectric is Teflon, rather than traditional mica. "TSG" will operate up to 100 C. and meets JAN C-5, types E, F and G. Its *Q* is three to five times that of mica capacitors.—*Condenser Products Co., 140 Hamilton St., New Haven, Conn.*

For more information circle **349** on inquiry card.

Temperature-insensitive Capacitors

New "Type GC" low-temperature-coefficient capacitors with plastic film dielectric for use in integrating circuits, tuned filters and timing oscillators, feature a temperature coefficient of 30 ppm./deg. C. Available in capacitance from 0.1 to 10 uf., voltages from 100 to 1000. Excellent capacitance retrace.—*Plastic Capacitors, Inc.*, 2511 *W. Moffatt St., Chicago* 47, *Ill.*

For more information circle **350** on inquiry card.

Motor Capacitors

New "Style MKV" a-c. oval case, paper-oil motor capacitors are cased in drawn oval hermetically-sealed terneplate containers. Terminals

mounted on covers are protected by synthetic rubber boots through which flexible insulated leads are brought out. Choice of 2 boot sizes and 5 bracket styles.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

For more information circle **351** on inquiry card.

ELECTROMECHANICAL COMPONENTS

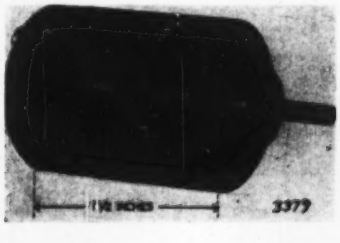
Slip-ring Assemblies

New slip ring assemblies for high temperature applications are made possible by development of new plastic, "ETC-7," which withstands –60 F. to 500 F. and has other desirable properties such as low water absorption, high surface resistivity, and excellent impact strength and dielectric properties.—*Electro Tec. Corp., South Hackensack, N. J.*

For more information circle **352** on inquiry card.

Tachometer Generators

New d-c. tachometer generators incorporate a permanent-magnet field assembly. Over-all body length less than 1½ in.; weight less than 3 oz. Principal uses: as a rate generator in servo systems; as tachometer when combined with a standard 1000 ohms per volt voltmeter; as under- or over-speed indicators, speed synchronizing controls, etc. Output voltage is controlled to within 1 percent of same value for either direction of rotation. Individual tests prior to shipment in-



Meet the Widest Range of flow measurement requirements with AMERICAN-WESTCOTT A-88 ORIFICE METERS

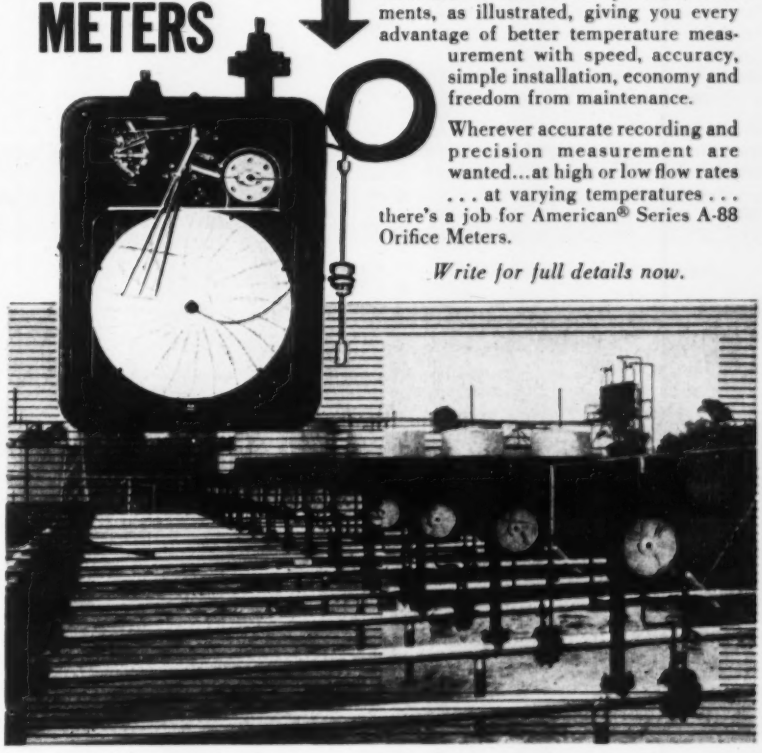
RECORDING · INDICATING INTEGRATING · TELEMETERING

American A-88 standard mercury type orifice meters for working pressures to 5000 psi. in interchangeable 10, 20, 50, 100 and 200-inch ranges give you complete versatility to meet any flow measurement requirement. Integrating instruments integrate both static and differential pressures giving totalized flow indications and telemetering equipped instruments transmit integrated indications to remote locations.

Recording Meters may be equipped with standard O-150°F. Temperature Elements, as illustrated, giving you every advantage of better temperature measurement with speed, accuracy, simple installation, economy and freedom from maintenance.

Wherever accurate recording and precision measurement are wanted...at high or low flow rates ... at varying temperatures ... there's a job for American® Series A-88 Orifice Meters.

Write for full details now.



AMERICAN-WESTCOTT MERCURY MANOMETERS GIVE YOU ALL THESE ADVANCED DESIGN FEATURES . . . . . .

- Minimum Simple Maintenance—easy access to float lever arm during calibration.
- Highest Accuracy—inherent straight line calibration.
- Interchangeable Ranges—no manifold piping changes.
- Pressure-Tight Teflon-Packed Stuffing Box—nearly frictionless, free from maintenance troubles, never needs lubrication.
- Teflon-Packed Pulsation Dampener—externally adjustable under full line pressure without leakage.
- Dependable Performance—improved check valves give positive shut-off for over-range protection.

AMERICAN METER COMPANY

GENERAL SALES OFFICE: 1523 Race Street, Philadelphia
Albany • Alhambra • Atlanta • Baltimore • Birmingham
Boston • Chicago • Dallas • Denver • Erie • Houston
Kansas City • Los Angeles • Minneapolis • New York
Omaha • Pittsburgh • San Francisco • Seattle • Tulsa
IN CANADA: Canadian Meter Company, Limited, Hamilton
Edmonton • Calgary

For more information circle **93** on inquiry card.

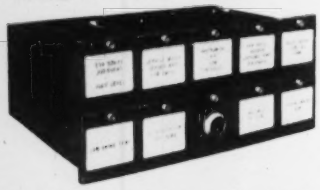
SCAM: FIRST

with these broad and basic developments in the ANNUNCIATOR FIELD!

FIRST AUTOMATICALLY AND CONTINUOUSLY SELF-SUPERVISED CIRCUIT.

With the DE Line, Scam pioneered the development of self-policing alarms with many new and versatile features. Each standard Plug-In operates from either NO or NC field signals . . . each has a simple lock-in for momentary alarms . . . each has an auxiliary contact for remote indication either NO or NC. Scam Special Plug-Ins provide HI-LO Level indication and sequential signals.

FIRST WITH STANDARD, COMPACT CABINET DESIGN.



Scam single-three-five-seven or eleven-unit cabinets require the least panel area and may be arranged in a variety of ways to provide maximum utility. Any Scam plug-in —special or standard—fits into the Cabinets without any chassis wiring changes.

FIRST TO OFFER AN ECONOMICAL, COMPACT, SINGLE-DUTY, SELF-MONITORING ALARM.

The Fail Safe *Econ Line* made possible positive identification of trouble sources and offered industry an opportunity to extend alarm usage on an economical and practical basis.

For the complete story of Scam please mail the coupon.

Scam circuits patent pending.

Mail Today! Mail Today!

SCAM INSTRUMENT CORPORATION

SCAM INSTRUMENT CORPORATION
3909 W. Irving Park, Chicago 18, Illinois

Send complete literature on the SCAM line.

NAME_____

POSITION_____

ADDRESS_____

CITY_____ **STATE**_____

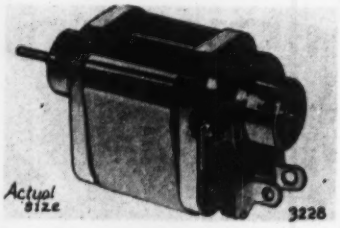
For more information circle **54** on inquiry card.

clude testing by oscilloscope for minimum ripple component. Outputs 2.5 or 7 v./1000 rpm.—*Servo-Tek Products Co., Inc.*, 1086 *Goffle Rd., Hawthorne, N. J.*

For more information circle **353** on inquiry card.

PM Miniature Motor

New permanent-magnet miniature motor (1/50 hp.) is said to be powerful for its size: torque 0.2 oz.-in. It



has a wide speed range (5000-20,000); voltages from 1½ to 28 volts. It can be used for actuators, automatic cameras, etc.; can be equipped with gear trains and governor.—*Small Motors, Inc.*, 2076 *Elston Ave., Chicago* 14, *Ill.*

For more information circle **354** on inquiry card.

Tachometer Generator

New "A-c. Rate Generator," for linear translation of rotational motion into voltage, is available in four models for 60- and 400-cps. operation; features a high-purity copper alloy cylindrical dragcup rotating in air gap between a cylindrical stator and a core; functions as a two-phase induction generator.—*Ford Instrument Div., Sperry Corp.*, 31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

For more information circle **355** on inquiry card.

Generator-servomotor Packages

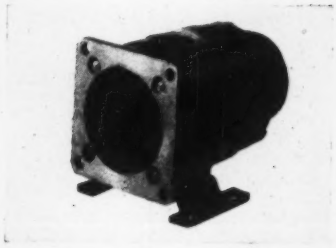
New rate-generator and servomotor single-shaft packages consist of maker's new "dragcup tachometer"

generator combined with any of maker's 10-watt high-torque low-inertia servomotors.—*Ford Instrument Co., Div. of The Sperry Corp.*, 31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

For more information circle **356** on inquiry card.

Tachometer Generator

New d-c. tachometer generator is designed for control applications as well as for speed indication; provides unusually high voltage output of 50



v./1000rpm. for speeds up to 5000 rpm. and 100 v./1000rpm. for speeds up to 2500 rpm.; is totally-enclosed, can be either flange- or foot-mounted to be direct-coupled, geared or belt-driven; horizontally or vertically.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **357** on inquiry card.

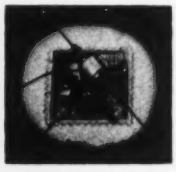
Motor Protectors

New "Mini-Breaker Motor Protector" is intended to protect equipment rather than wiring; can be used in a

cut-out base wired to motor or equipment to safely interrupt excessive overloads and short circuits. It trips instantly on shorts but has built-in time lag to handle temporary starting loads and line surges. Service can be restored within 10 seconds after an interruption by pressing shock-proof reset button. It is trip-free and will not maintain a circuit that has not been cleared of overload-causing condition. Any attempt to reset against overload or short only increases speed of tripping. Available in 4-amp. to 7½-amp. ratings.—*Mechanical Products, Inc.*, 1800 *River St., Jackson, Mich.*

For more information circle **358** on inquiry card.

Subminiature Relays

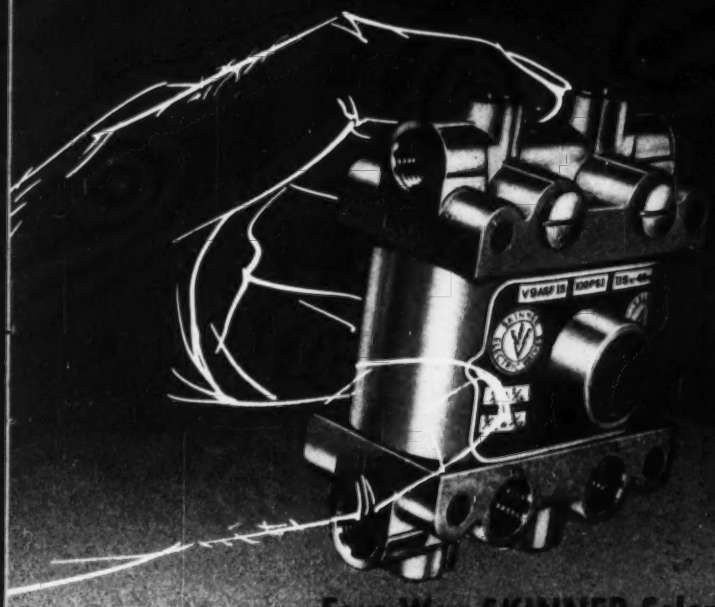


New "Magseal Relays" include unit said to be "the smallest relay in the world," which can be actuated by a photocell since it only requires 18 mw. to effect contact closure. Contacts and actuating elements are magnetic rods sealed in glass; differ from conventional design in that only contacts are sealed. Available in a variety of sizes; units having up to 109 contacts in one assembly have been built.—*G. W. Giannini & Co., Inc., Electromechanical Div., East Orange, N. J.*

For more information circle **359** on inquiry card.

Miniature Relays

New "Series 22" relays feature bifurcated (twin) contacts for reliable switching of extremely low voltage and low current. Flexibility of long bifurcated contact springs enables twin points to make contact independently. Units available for a-c. or



TINY AND TERRIFIC!

V9 Series
Only 4 5/16" High

Four-Way SKINNER Solenoid Valve

Cuts Initial Cost... Saves Space... Reduces Maintenance

This four-way Skinner V9 Series Valve is ideal for new equipment design — and for modernizing production equipment. Compact and accurate, it is extremely dependable and versatile — more than 178 variations of capacities, metering and types are available.

The V9 will operate medium-size single and double-acting air and hydraulic cylinders, and large pilot-operated diaphragm valves. It is offered in three basic types: normally closed, normally open, or combination — normally open and closed.

Media — Air, inert gases, hydraulic oils, and other common media.

Pressure Rating — 0-150 p.s.i.

Millions of Cycles — Even at operating speeds up to 600 cycles per minute.

Temperature — Minus 65°F. to Plus 150°F.

Construction — Leakproof sealing — bubble-tight shut-off at all ports; packless, frictionless construction; die-cast zinc bodies, stainless steel internal parts. Coils are moisture-resistant, varnish-impregnated.

Specifications — Duty Cycle — continuous.
Pipe Size — all pipe connections ¼" NPT.
Electrical Outlet — ½" NPT conduit.
Voltage — all common AC and DC voltages.
Power Consumption — both coils, 20 watts maximum.

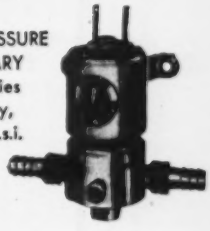
Rely on Skinner's nation-wide resident engineers and stocking distributors — plus highly-skilled Skinner plant engineers — for prompt delivery and expert service!

UNIVERSAL
V5 Series
2- & 3-Way,
0-1000 p.s.i.

MINIATURE
CUT-OFF
V2 Series
2-Way,
0-250 p.s.i.

QUICK EXHAUST
(extra fast
cylinder return)
V5-3 Series
3-Way,
0-150 p.s.i.

HI-PRESSURE
HYDRAULIC
V10 Series
2- & 3-Way,
0-1000 p.s.i.



LOW PRESSURE
SANITARY
V4 Series
2-Way,
0-20 p.s.i.

EXPLOSION-
PROOF
X5 Series
2- & 3-Way,
0-1000 p.s.i.

HI-FLOW INDUSTRIAL
M Series
2- & 3-Way,
5-150 p.s.i.

World-Wide Representation — Immediate Delivery on Standard Valves

SKINNER SOLENOID VALVES

SKINNER ELECTRIC VALVE DIV.
The Skinner Chuck Company
117 Edgewood Avenue
New Britain, Connecticut
Send us bulletins on the following Skinner valves:

.....

.....

Have Skinner representative call.....
Name.....
Company.....
Street.....
City.....*Zone*....*State*.....

SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

For more information circle 95 on inquiry card.

MINIATURE
AN-type
CONNECTORS

SPECIAL FEATURES:

- ★ ⅓ the weight of standard AN connectors
- ★ Pressure-proof
- ★ Waterproof, mated or apart
- ★ "O" ring sealers
- ★ Spun-in sandwich construction on female connectors
- ★ Aluminum shells with *hard-cote* grey anodic finish
- ★ Gold-plated contacts
- ★ Famous AMPHENOL 1-501 blue dielectric
- ★ Unique built-in cable strain relief

Design engineers have long requested a miniature version of standard AN connectors. And here is the answer: the new AMPHENOL 165 series of miniature AN-Type connectors have the *identical electrical qualities* of standard AN's compressed into only *one-third* the weight! Now designers of electronic equipment requiring AN connectors can utilize the 165 series instead and show substantial savings in both weight and space.

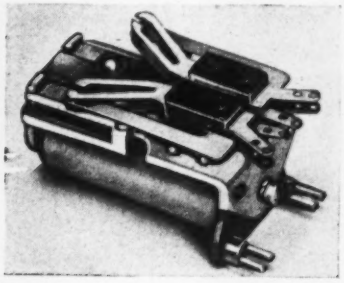
The 165 series are available in two connector sizes and six contact configurations. The small size is obtainable in 5, 9 or 12 contacts; the "large" size in 11, 14 or 24 contacts—all have male or female inserts in plug or receptacle.

For more complete information about the 165 series, write and request "Amform 2397."

AMERICAN PHENOLIC CORPORATION
Chicago 50, Illinois
In Canada

AMPHENOL

NEW INSTRUMENTS

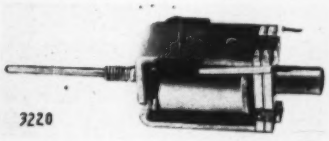


d.c., in open types, as well as in hermetically sealed and dust-tight enclosures.—*Magnecraft Electric Co.*, 1442-H *Van Buren St., Chicago 7, Ill.*

For more information circle **360** on inquiry card.

Custom Solenoids

New "Series 100 and 300" d-c. solenoids permit 300 different solenoids to be assembled from twenty standard parts. Among features: simplified

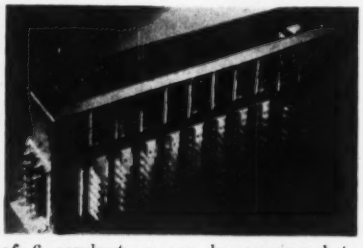


change-over to push or pull type; maximum power for minimum size; wide variety of mountings, coils and wire sizes.—*Joseph Pollak Corp.*, 81 *Freeport St., Boston 22, Mass.*

For more information circle **361** on inquiry card.

Crossbar Switch

New "Type P" crossbar switch features ability to handle high frequencies, extremely low crosstalk level; has 2 lines and 10 links with a maximum of 6 conductors per circuit; upper two



of 6 conductors can be arranged to serve as holding circuits for magnet coils. Each of 20 "crossovers" is controlled by an individual magnet coil. This switch, in effect, can perform function of twenty 6-pole relays bussed together, but without ordinary relay's limitations in higher frequencies. Each circuit behaves essentially as a transmission line of 110 ohms impedance up to a frequency of approx. 200 Mc. Highest standing-wave ratio from dc. up to this frequency is 1.15 when circuits are properly matched. Modifications are possible, in that number of conductors per circuit can be reduced, number of links can be reduced, and several of these switches can be conveniently stacked.—*James Cunningham Son & Co., Inc., Rochester 8, N. Y.*

For more information circle **362** on inquiry card.

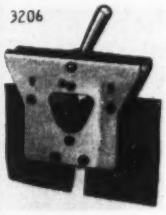
← Circle **96** on inquiry card.

Paralleling Switch

New "Type SW" high-precision paralleling switch provides additive switching whereby each position brings in circuitry in parallel with circuitry switched in by previous setting. Primarily designed for use in capacitance decade work and has many other applications owing to its low resistance and capacitance and self-cleaning features.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **363** on inquiry card.

Toggle Switches



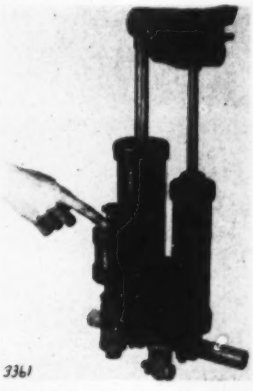
New "11AT Family" of six three-position toggle switches, features ability to make or break circuits in all three toggle lever positions, made possible by use of two s-p.d-t. basic switching units in each switch. Toggle positions are as follows: 11AT1 & 11AT6 maintained, maintained neutral, maintained; 11AT2 & 11AT7 momentary, maintained neutral, momentary; 11AT4 & 11AT8 momentary, maintained neutral, maintained. Ratings: 30 v.dc.: inductive: 10 amps at sea level, 6 amps at 50,000 feet; resistive: 10 amps; motor load: 6 amps. UL listed for 10 amps. 125 or 250 v.ac., 0.5 amp. 125 v.dc. 0.25 amp. 250 v.dc.—*Micro Switch, Freeport, Illinois.*

For more information circle **364** on inquiry card.

MECHANICAL COMPONENTS

Air-hydraulic Power Unit

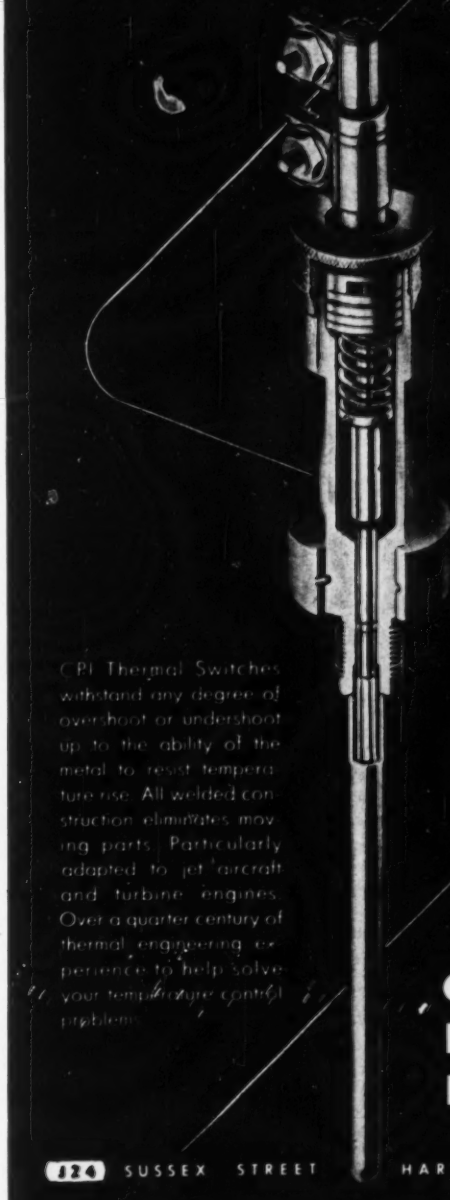
New three-cylinder power unit weighing 41 lbs. combines fast stroke, damped terminal stopping, powerful finish pressures and full reversibility. It achieves long (7-in.) stroke and



fast operation through pneumatic-cylinder action, and powerful closing force (2100 or 5600 lbs.) through differential hydraulic-piston principle. Air requirement per cycle is less than 0.11 cu. ft. Three cylinders: one for fast, long pneumatic stroke (at right); largest (left) providing the 12-to-1 hydraulic multiplication of trapped oil pressure for the finishing stroke (and incorporating constant-

1200°F..1500°F..2000°F!

CPI super high-temp thermal switch



- FASTER RESPONSE DUE TO LOWER THERMAL MASS
- MAINTAINS UNUSUALLY CLOSE TEMPERATURE CALIBRATION
- OPERATING TEMPERATURES TO 1700°F
- OVERSHOOT TO 2000°F
- MAXIMUM VIBRATION RESISTANCE
- CONSTRUCTED OF HIGH TEMPERATURE ALLOYS
- LIGHTWEIGHT (Approx. 6 ounces)
- PLATINUM IRIDIUM CONTACTS FOR LONG LIFE

CPI Thermal Switches withstand any degree of overshoot or undershoot up to the ability of the metal to resist temperature rise. All welded construction eliminates moving parts. Particularly adapted to jet aircraft and turbine engines. Over a quarter century of thermal engineering experience to help solve your temperature control problems.

CONTROL PRODUCTS INC

124 SUSSEX STREET HARRISON · NEW JERSEY

For more information circle **97** on inquiry card.

ONE $925.00* CHAMBER FOR ALL YOUR TEMPERATURE TESTING PROBLEMS

Here's a temperature test chamber to fit every test program. Combining features not offered in any unit of comparable price, it reflects the long-term experience of one of the nation's leading environmental test facilities—Wyle Laboratories—where it was developed.

Simplicity . . . and the highest quality materials and workmanship . . . combine for rugged, permanent dependability. Full-opening, counterbalanced lid, access holes for actuation lines or instrument leads, and an insulated observation window provide outstanding operating convenience.

In the laboratory with only a light work load, the D-102's wide range makes it a complete temperature test facility. In the busier laboratory, the unusually low price permits purchase of several units to break a testing bottleneck.

Complete information on request.

*FOB EL SEGUNDO, CALIF., UNCRATED

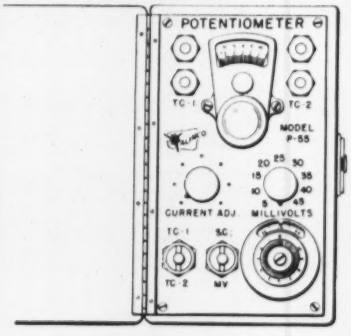
- −100° to +300°F, ±2°F accuracy.
- Fully automatic . . . dual thermostats for high and low temperatures.
- 12 cu. ft. working volume, stainless steel lined.
- Block dry ice refrigerant.
- High-efficiency 6" glass wool insulation.

MANTEC INC.

132 Maryland Street • El Segundo, California

For more information circle **98** on inquiry card.

A miniaturized POTENTIOMETER



The miniaturized Potentiometer, Model P-55, weighs only three and one half pounds, and measures just 4 1/8 x 4 1/2 x 7 1/2 inches, yet is accurate to 0.02 millivolts. The dual input is equipped with an internal switch. The battery life is two years. $215.00

ALINCO

ALLEGANY INSTRUMENT COMPANY
incorporated
1000 Oldtown Road
Cumberland, Maryland

For more information circle **99** on inquiry card.

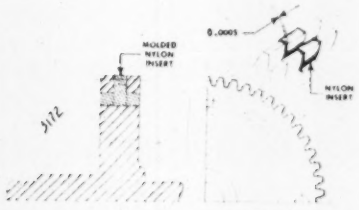
NEW INSTRUMENTS

deceleration, terminal checking and temperature-independence features); third is booster cylinder to trigger high-pressure finish stroke. Booster cylinder (to which finger points) is available in sizes for either regular or heavy-duty finish pressure. Main stroke speed is adjustable without affecting decelerating characteristics. Hydraulic closing force at end of forward stroke is independently adjustable. Cycle may be taken in steps timed manually or automatically by treadle, lever, button, cam or timer arrangements.—*Pantex Mfg. Corp., 521 Roosevelt Ave., Pawtucket, R. I.*

For more information circle **365** on inquiry card.

Gear Boxes

New "Min-a-lash" gear boxes solve problems of backlash in gear trains used for precision control in aircraft, ordnance, radar and research equip-

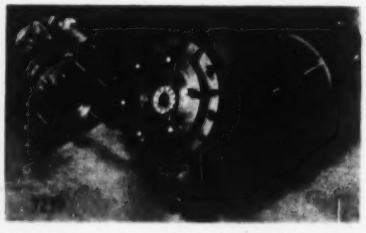


ment. Gears have a central lamination or wafer of nylon flanked on either side by steel. After cutting, nylon portion grows slightly to increase tooth thickness enough to minimize backlash without increasing torque. Load is not taken by nylon but by outside steel portions. In illustrated application (90:1 ratio and output torque rating of 30 oz.-in.) 1.0 oz.-in. friction torque was permitted but it is held to 0.375 oz.-in. and backlash of complete train measures 0.02 deg. —*Dexter Machine Products Co., Chelsea, Mich.*

For more information circle **366** on inquiry card.

Aircraft Accessory Drives

Three new types of accessory drive units for aircraft application: "Model 166 1676E2" alternator drive gear



box; "Model 1604E35" hydraulic pump drive; and "Model 1651E130" hydraulic pump adapter. All will operate at temperatures from −65 F. to 200 F. —*Western Gear Works, P. O. Box 182, Lynwood, Calif.*

For more information circle **367** on inquiry card.

Plastic Pipe

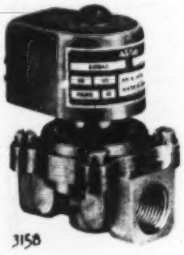
New polyethylene-base flexible plastic pipe, designed to eliminate deteriorating effect of sunlight, is flexible and lightweight; is produced from

pure virgin materials and contains no anti-oxidants or pigments that would tend to make it toxic. No reprocessed or off-grade material of any kind is used in its manufacture. Among other features: unconditional guarantee against electrolytic corrosion, rust and rot; extremely low friction loss; no interior build-up; immunity to effects of corrosive waters, soils and a wide range of chemicals including most solvents. Nine standard sizes up to 6-in. dia.; complete line of fittings.—*Munray Products, Inc.*, 12400 *Crossburn Ave., Cleveland* 11, *Ohio.*

For more information circle **368** on inquiry card.

VALVES

Packless Solenoid Valves



New 2-way solenoid valves may be used for controlling air, gas, water, light oil, and other noncorrosive fluids; are available normally-closed or normally-open, with standard, watertight, or explosion-proof solenoid enclosures; pipe sizes ⅜, ½, ¾ and 1 in. Maximum pressure (on air): 250 psi. (N-O), 200 psi. (N-C). All standard a-c. and d-c. voltages; power consumption 10 watts. Other features: mountable in any position; absolutely tight shut-off; continuous duty coil; forged brass bonnet and body insure freedom from porosity.—*Automatic Switch Co., Orange, N. J.*

For more information circle **369** on inquiry card.

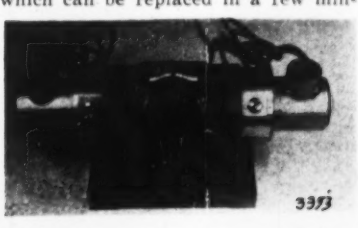
P.V.C. Valves

New polyvinyl chloride (P.V.C.) valves have been added to "Saunders Patent Diaphragm Valve" line, thereby expanding list of corrosive materials that can be handled successfully. It also provides a corrosion-resistant valve for P.V.C. piping layouts. Hand-wheel-operated, lever-operated sliding-stem and air-operated types are available; sizes from ½-in. through 2-in.; screwed ends standard; slip fits available on special order.—*Hills-McCanna Co.*, 3025 *N. Western Ave., Chicago* 18, *Ill.*

For more information circle **370** on inquiry card.

Four-way Valves

New "MV Series" 4-way valves for air or hydraulic service to 200 psi. features simplicity of design, versatility of application, and ease of installation and service. Only moving part is one-piece spool, which carries only moving seals; standard "O" rings which can be replaced in a few min-



and Size 11

Cppc's SIZE 10 SERIES SYNCHROS *Available Now!*

In quantity production . . . available for immediate delivery . . . is this high performance series of standard Size 11 Synchros . . . 1.062" diameter.

Minimum weight—1 full oz. lighter! Magnetics of optimum proportions are built into:

- Transmitters
- Receivers
- Resolvers
- Differentials
- Control Transformers
- Sine-Cosine Generators

Another product of the engineering team which pioneered precision synchros.

For full engineering information, drawings, electrical characteristics, etc., write or telephone T. W. Shoop, Sales Dept. Telephone (Phila.) MAdison 6-2101. West Coast Rep. Wm. J. Enright, 988 W. Kensington Rd., Los Angeles, Calif. MUtual 6573.

LOOK TO *cppc* FOR SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS **PENNSYLVANIA**

For more information circle **100** on inquiry card.

KARN
THERMOWELLS

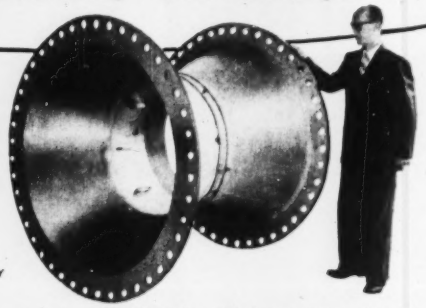
KARN · CHEMICAL · EQUIPMENT · COMPANY
518 DICKSON AVENUE · PITTSBURGH 2, PA.

For more information circle **101** on inquiry card.

it's REVERSIBLE

The *Gentile** **FLOW TUBE** measures flow in either direction

*GEN-TIL-LY



REVERSIBLE . . . The Flow Tube is symmetrical, with upstream and downstream ports identical. When the flow is reversed, the differential is reversed. Permits metering reverse flow at lowest possible equipment cost

LOW INSTALLED COST . . . Average length is only 1½ times the pipe diameter, and straight runs entering and following are not required unless installed near throttling valves or regulators

ACCURACY . . . Produces differential from points of equal cross-sectional area . . . furnished with head capacity curves, and guaranteed for exceptional accuracy when used with any standard indicating, recording or integrating meter

LOWEST HEAD LOSS . . The Flow Tube can be designed to produce a measurable differential with the lowest permanent pressure loss of any type head meter

Write for Bulletin FT-101, or for specific recommendations.

75 YEARS OF EXPERIENCE

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE · UNION, N. J.

AUTOMATIC VALVES • SAFETY VALVES • FLOW TUBES

For more information circle **102** on inquiry card.

utes. New valves are readily adapted to sub-base, manifold, panel, console or conventional piped installations. Full line of standard attachments provide for operation by lever, palm button, foot pedal or treadle roller, cam, solenoid, pilot or remote bleeder button. One body casting accommodates ⅜ or ½-in. pipe ports; another, ¾ and 1-in. pipe ports.—*Modernair Corp., 400 Preda St., San Leandro, Calif.*

For more information circle **371** on inquiry card.

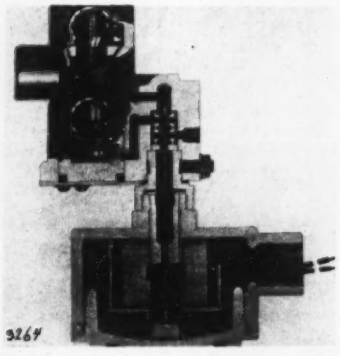
Stainless Steel Valves

New lower-priced line of stainless-steel lubricated plug valves, for use in food, plastic, sulfite pulp and chemical plants, feature chrome-plated plugs; are suitable for most services in which maker's more expensive stellite-coated stainless steel valves have previously been used; are offered in sizes and types available in higher-priced line.—*Meter and Valve Div., Rockwell Mfg. Co., 400 North Lexington Ave., Pittsburgh 8, Pa.*

For more information circle **372** on inquiry card.

Solenoid Air Valves

New explosion-proof solenoid air valves feature extremely short solenoid stroke which, in conjunction with pilot operation, prevents coil burn-



out. Poppet design with linear sealing contact on resilient seats makes both pilot and main valve self-scavenging. Cover of explosion-proof housing is removable for quick access to solenoid; coils are interchangeable.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

For more information circle **373** on inquiry card.

Relief Valves

New versions of maker's spring-loaded relief valves feature single-spring construction which eliminates unstable superstructure. Design minimizes over-all spring length. This, combined with large coil diameter and heavy cross wire section; is said to result in an ideal l/r ratio which provides maximum spring stability. Spring is constructed for least pos-

sible difference between pressure required to unseat valve and that required to force it full open. Use of "reach nuts" (essentially bushings threaded at the lower ends) eliminates long spring rods extending above valve and permits use of rods which do not extend beyond upper spring plate after compression. For ease of adjustment, thrust bearings are used under spring nuts when high relief pressures require greater spring forces. Two modifications also available: (1) adjustment of relief pressure by handwheel which varies spring tension; (2) handwheel and jacking assembly permitting free flow through valve when required.—*Schutte and Koerting Co., Cornwells Heights, Bucks County, Pa.*

For more information circle **374** on inquiry card.

Diaphragm Valves

New "X-V Series" valves feature greater port capacity, that permits use of smaller piping with lower pressure drop, plus connections that are re-usable in maintenance replacement.

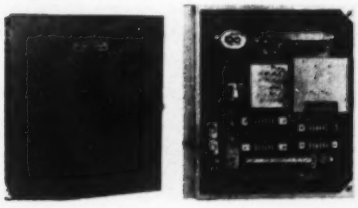
Designed primarily for shut-off, throttling and control of acids and chemicals in corrosive or abrasive service, many types are lined. Capacities as much as 50 percent greater than other valves of similar construction. Exclusive feature is a novel union which allows for lining to come up over face of union and to come in contact with union tailpiece of special material. Pressures up to 150 psig at maximum temperature of 180 F.—*Farris Flexible Valve Corp., 610 Commercial Ave., Palisades Park, N. J.*

For more information circle **375** on inquiry card.

MISCELLANEOUS

Voltage Regulator

New "Recostat," said to be "the first universal magnetic amplifier voltage regulator for exciter control application," can control generators from 5 to 150 kw. Prime movers may include diesel or gasoline engines, induction, synchronous or d-c. motors, steam or gas turbines. Among features: response of 1/400th second which



HOKE

Flow Sheet

Hoke reports on fluid control

scientific nose

Motorists in vehicular tunnels throughout the nation may owe their lives—or at least their comfort—to Carbon Monoxide Detection Equipment manufactured by Taller & Cooper, Inc., of Brooklyn, N. Y. Says Stanley A. Kroll, vice-president, "We have always specified Hoke Toggle Valves for our equipment because of the close tolerances to which Hoke products are made. Once a Hoke Valve is placed in the line, no maintenance is required."

If you have a similar toggle valve application, we'll be glad to send you catalog and data sheets, pronto.

water—pure and simple

Pure, demineralized water—whenever you want it. That's the purpose of the Barnstead Pressure Bantam Water Demineralizer, a product of Barnstead Still and Sterilizer Co., of Boston, Mass. An important part of this equipment is a Hoke Needle Valve, chosen because of "its compact size and its precise flow regulation characteristics." Hoke Needle Valves come in sizes ⅛" to ½" in aluminum, brass and stainless steel.

triple-threat valve

"We tested many valves for our Infra-Red Gas Analyzer before selecting Hoke," says Max D. Liston, of Liston-Becker Instrument Co. "We had three requirements in mind. First, the valve must withstand corrosive gases and environments; second, it must not leak in the closed position, holding a charge for as long as a year; third, it must fit into a very limited space. So far, Hoke Valves have met all requirements."

Do you have a tough job for a small valve? Why not let us offer our suggestions?

HOKE

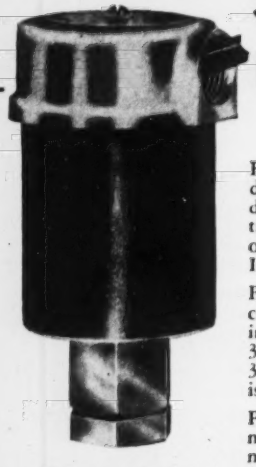
HOKE INCORPORATED

Flow Control Specialists

For more information circle **103** on inquiry card.

New! Atkomatic SOLENOID Stainless Steel Direct Lift Valve

to 5000 P.S.I.



Rugged, simple, compact, heavy-duty, two way valve for broad industrial applications. Assures continuous service, nothing to wear out, has only two moving parts. Instantaneous action.

Features higher pressures, greater corrosion resistance. 1/8 and 1/4 inch pipe sizes, orifices 1/16 to 3/16 inch diameter. Bodies are 303 Stainless, Solenoid armature is 416 Stainless.

Pressures: 5000 P.S.I. to 150° F. maximum, 2500 P.S.I. to 475° F. maximum. Paper insulated coils up to 180° F., glass insulated, silicone impregnated up to 475° F.

Write for Bulletin No. 100

ATKOMATIC VALVE COMPANY
525 ABBOTT STREET INDIANAPOLIS 25, INDIANA

For more information circle **104** on inquiry card.

ENGRAVE
NAME PLATES • PANELS • DIALS
in your own shop

Lowest set-up time for unskilled labor

10,000 in use. The speediest, most versatile portable engraver. Only the NEW HERMES has these features:

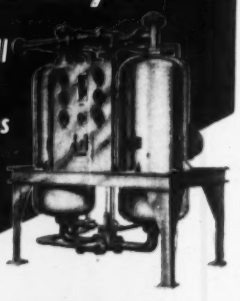
• Adjustable for 15 ratios. • Self-centering holding vise. • Automatic depth regulator. • Adjustable copy holders.

Send direct to us for booklet IN 87

NEW HERMES ENGRAVING MACHINE CORP.
13-19 University Place, New York 3, N. Y.

For more information circle **105** on inquiry card.

The Instrument Air Dryer
with all the features



★ Exclusive Finned System Desiccant Chambers
★ Automatic, Semi-Automatic, or Manual Control
★ Compact Functional Design (ASME Code)
★ Safety Interlock Control System
★ Atmospheric and Pressure Regeneration Circuits
★ Moisture Indicator and Instruments Panel Mounted
★ Superior Desiccant
★ Exit Dewpoint below minus 40° F at line pressure
★ Steam and Electric Reactivation

Submit your Dryer problems to our experienced instrument engineers.

SEND FOR Illustrated Bulletin

3170

Industrol CORPORATION

494 Westfield Avenue, East • Roselle Park, New Jersey

For more information circle **106** on inquiry card.

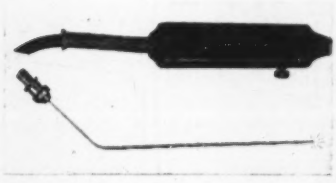
NEW INSTRUMENTS

equals any electronic exciter regulator; operates with generators rated at 120, 208, 220, 440 or 480 v. single or three-phase; frequency 380 to 420 cps.; accuracy 1 percent under extreme swings of exciter field voltage; no moving parts; no adjustments or attention or tube changing.—*Regulator Equipment Corp., Paterson, N. J.*

For more information circle **376** on inquiry card.

Inspection Light

New "Eder-Lite" extension fits in tiny openings or crevices; has grain-of-wheat bulb (1/8-in. maximum

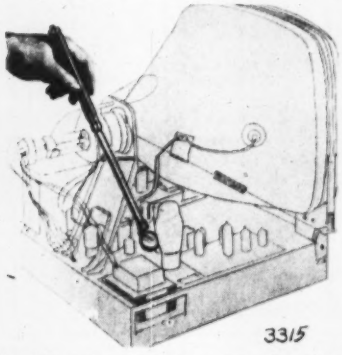


diam.); extension shaft stem 3/32-in. diam. Other extensions, 1 in. to 36 in., flexible or rigid, fit same unit.—*Dept. 30, Eder Instrument Co., 2293 N. Clybourn, Chicago 14, Ill.*

For more information circle **377** on inquiry card.

Illuminated Inspection Mirror

New "Illuminated Inspection Mirror," in appearance similar to a dentist's oral inspection mirror, is much longer (12¼ in.), enabling serviceman to inspect inaccessible parts of chas-



sis. No external cords: two "penlite" cells. Use of Lucite rod and other dielectric materials prevents risk of shock or shorting.—*General Cement Mfg. Co., 919 Taylor Avenue, Rockford, Ill.*

For more information circle **378** on inquiry card.

Combination Wire Tool

New "Wonder Wire Worker" is a fine-pointed tweezer with a cutting

edge and insulation-stripping notches; will strip #16-22 insulated wire and cut up to #16 stranded or solid wire; is also wire crimper.—*Lindly & Co., Inc., 248 Herricks Rd., Mineola, L. I., N. Y.*

For more information circle **379** on inquiry card.

Planimeter

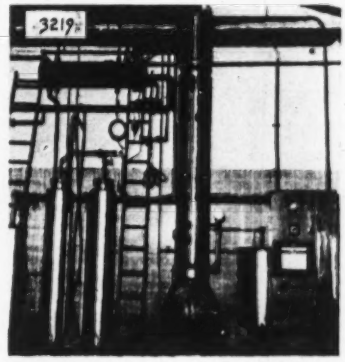
New "Model 1100 Large Area Easy Read Optical Planimeter" features unique carriage enabling area measurements 32 in. wide and unlimited in

length. Large roller makes reading of vernier easier and more accurate. Optical Tracer Point has a 60-deg. cone of vision to facilitate tracing and eliminate parallax errors.—*Los Angeles Scientific Instrument Co., 2451 Riverside Drive, Los Angeles 39, Calif.*

For more information circle **380** on inquiry card.

Packaged Pilot Plant

New "Fractioneer" is a completely automatic and instrumented packaged pilot and small-scale production dis-

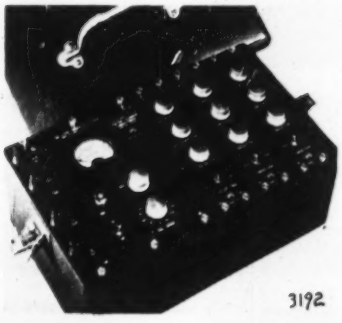


tilling plant especially suitable for vacuum fractionation of essential oils down to 5 mm. abs. pressure, crude oil evaluation, purification of small chemical batches, etc.—*Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill.*

For more information circle **381** on inquiry card.

Seismic Log Level Indicator

New "Model LLI" aids in seismic "noise" analysis and pattern hole and multiple seismometer shooting; operates with any standard seismic system, receiving its input from regular seismometer signals and furnishing output directly to recording camera. Its trace (amplitude proportional to logarithm of input signal) provides a calibrated indication of signal strength throughout length of seismograph rec-



3192

Quickly set—holds temperature constant

Here's a proved way to modernize and *save* on your processing operations. With this dependable Sylphon Regulator, you can make quick changes in temperatures for liquids, air or gases. Simple turn of the crank adjusts the temperature to the setting desired. Ideal for applications requiring frequent temperature changes to suit processing stages.

More advantages! You are assured of uniform processing conditions. Spoilage is reduced. Wasteful overheating is prevented. You save manpower, man hours and fuel.

Sylphon Regulator No. 923-Q has many uses: with open and closed tanks, bottle washers, glue kettles, dishwashing machines, slashers and other units. Sturdily built for years of trouble-free service. Recommended as standard equipment. Write for information. Or, ask about a Sylphon Control for *your* specific operations. Send for Catalog VE-D.

Robertshaw-Fulton

CONTROLS COMPANY

FULTON SYLPHON DIVISION • KNOXVILLE 1, TENN.

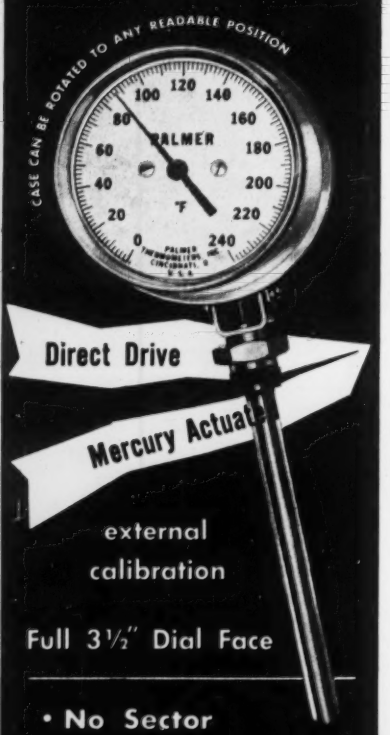
For more information circle **107** on inquiry card.

PALMER

presents

an outstanding improvement in

DIAL THERMOMETERS



external calibration

Full 3½" Dial Face

- No Sector
- No Pinion
- No Linkage
- Constant Accuracy
- Easy Readability

WRITE FOR BULLETIN 350

PALMER

THERMOMETERS, INC.

Norwood Ave., Cincinnati 12, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

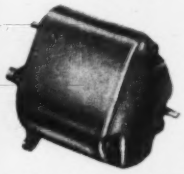
For more information circle **108** on inquiry card.

NEW INSTRUMENTS

ord and is completely independent of automatic gain control and other characteristics of seismic amplifier. "LLI" provides two logarithmic output signals, each log function derived in its own "compression" unit, with each output connected directly to an oscillograph galvanometer element. Selections on "compression" units include "sensitivity," "time constant," "output deflection," and "dynamic range select switch."—*Houston Technical Laboratories, 2424 Branard, Houston 6, Texas.*

For more information circle **382** on inquiry card.

Air-motor Chart Drive



New "A07 Series Miniature Chart Drive" operates on air supply 15 to 25 psi.; torque 8 oz.-in. maximum at 20 psi. Mechanism is enclosed in dust- and tamper-proof cover. Standard speed 1 rpm. clockwise or counter-clockwise. Self-starting temperature-compensated escapement insures accurate timekeeping within 1 deg. per rev. of output shaft. Unit is interchangeable with most electric drives; is explosion-proof.—*Seth Thomas Clocks Div., General Time Corp., Thomaston, Conn.*

For more information circle **383** on inquiry card.

Projector Camera

New "Projectina" macro and micro combination viewer-projector-camera permits study of transparencies and opaque objects. Eyepiece viewing includes 3 interchangeable oculars and 3 micro objectives (which can be supplemented by standard oculars and objectives of other makes) plus a special cross-hair eyepiece. Projection features include groundglass observation (with 2 supplementary projection objectives), 2 cross-hair graph screens for precise measurement readings, circular scale for determining angles, as well as wall-viewing for group study. Photography through 4x5-in. filmholder carrier interchangeable with groundglass, or a single-lens reflex camera attachable to eyepiece mount. Magnification from 10 up to 1500 times. Transmitted-light system and surface-light system can be combined for simultaneous examination of silhouette and surface, creating 3-dimensional relief effect. Over-all dimensions 9x11x18 in.; weight 40 lbs. —*Karl Heitz, Inc., 150 W. 54th St., New York 19, N. Y.*

For more information circle **384** on inquiry card.

Non-metallic Screwdriver

New "Peaker" is for manufacturers and service men who need a durable non-inductive alignment tool for sensitive settings which prohibit the use of metallic implements. It is a lightweight screwdriver with composition handle and reversible-tip hardened ceramic blade. Blade is of American Lava Corp.'s "AlSiMag 491" material which is extremely hard, (9 on Mohs' scale).—*Radio Industries, Inc., 5225 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **385** on inquiry card.

TV and Phone Intercom

New "TV Telephone Intercom System" resembles a 17-in. TV receiver with a phone handset mounted alongside screen. When person placing call lifts his handset, his image appears on one-half of TV screen. As called person answers, his image appears on other half of screen. Thus, both are visible at either end. Among uses: showing merchandise, personnel identification, inter-plant and inter-city conferences, surveillance and control. When phone is not being so used, TV monitor may be used for closed-circuit TV, for subscription TV or for off-the-air programs, with image displayed over entire screen area.—*Kalbfell Labs., P. O. Box 1578, San Diego 10, Calif.*

For more information circle **386** on inquiry card.

Particle Sizer

New Calibrator attachment for maker's "Sub-Sieve Sizer" measures particles too small for sieves (its

range: 0.2 to 50 microns) by determining resistance to air-flow of a weighed sample under standard packing condition .—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.*

For more information circle **387** on inquiry card.

Dehydrators for Instruments

New "Humi-Caps" are small one-piece transparent plastic dehydrators, produced in three sizes, in indicating and non-indicating types. They help prevent moisture damage in optical, aircraft and electronic instruments.—*DriAire, Inc., South Norwalk, Conn.*

For more information circle **388** on inquiry card.

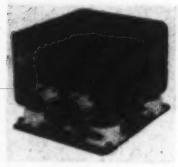
Excess-humidity Warning Devices

New "Humi-Spots" are cards impregnated with spots of moisture-sensitive material. Three standard types: two single-spot cards and one three-spot card, each showing different degrees of relative humidity; conforming to current military specs. ★"Humi-Eyes" external indicators show humidity conditions within a barrier package; are designed for Method II military packaging. ★"Dehydrator Plugs" control moisture inside equipment; can be used during service, transit and storage: color change of desiccant shows when replacement is necessary.—*DriAire, Inc., South Norwalk, Conn.*

For more information circle **389** on inquiry card.

Mach Number Computer

New "CA-500" force-balance-type Mach Number computer weighs 4½ lbs.; provides accuracy of 0.01 Mach for 95 percent of laboratory test points; obviates need for external pressure pickups and vacuum tubes. Maximum versatility: when combined with a temperature bulb and two local wind detectors mounted in air stream to supply local angle of attack and local angle of yaw, respectively, it produces voltages proportional to true angle of attack, true angle of yaw, Mach number, and true airspeed; ample torque for digital outputs, etc. —*Servomechanisms, Inc., Post and Stewart Aves., Westbury, L. I., N. Y.*



For more information circle **390** on inquiry card.

Motor-control Centers

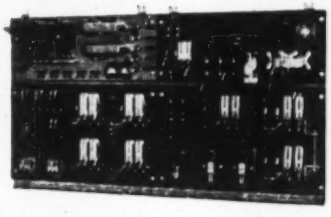
New "DA7093" motor control center will save up to 50 percent in floor space; will take nine NEMA Size One starter units, or six NEMA Size Two

units, of either fusible or circuit-breaker types. New "Type B" terminal blocks allow starter units to be removed or inserted without disturbing established wiring.—*Distribution Assemblies Dep't, General Electric Co., 41 Woodward Ave., Plainville, Conn.*

For more information circle **391** on inquiry card.

Industrial Hoist Control

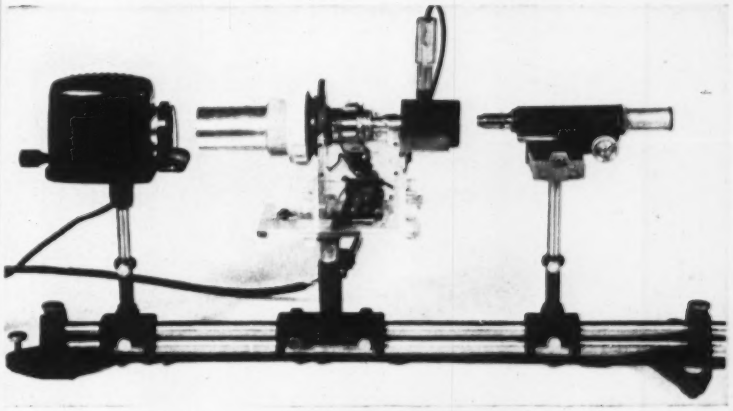
New "Bulletin 14166" a-c. hoist controller for use with wound-rotor motors combines unique characteristics



of eddy-current load brake and regulating magnetic amplifier: speed-torque curves previously unavailable on a-c. hoists.—*Cutler-Hammer, Inc., 256 N. 12th St., Milwaukee, Wis.*

For more information circle **392** on inquiry card.

A NEW APPROACH TO THE PROBLEMS OF INSTRUMENTATION



THE Meyer

UNIVERSAL INSTRUMENT BENCH

THE PROBLEM → TO PROVE OUT AND TEST INSTRUMENT SYSTEMS IN: OPTICS. ELECTRONICS, PHYSICS, PHOTOGRAPHY, ELECTRO-MECHANICS, AND ALLIED FIELDS

THE APPROACH → BY THE USE OF OVER 50 COMPONENTS WHICH CAN BE ASSEMBLED IN THOUSANDS OF COMBINATIONS. WITH ANY NUMBER OF THESE COMPONENTS A TREMENDOUS RANGE OF INSTRUMENTATION SETUPS CAN BE MADE IN A MATTER OF MINUTES.

THE SOLUTION → THE ILLUSTRATION SHOWS A SET-UP FOR TESTING THE IMAGE QUALITY OF AN ELECTRON TUBE OR THE OPTICAL PROPERTIES OF A LENS.

AREAS OF APPLICATION → FOR RESEARCH AND DEVELOPMENT ON THE PRODUCTION LINE IN ASSEMBLY AND INSPECTION INDUSTRIAL PHOTOGRAPHY

For a complete 20 page descriptive catalogue send to

Meyer-Opticraft, Inc.

(Formerly Hugo Meyer & Co.)

39 West 60th St. New York 23, N. Y.

For more information circle **109** on inquiry card.

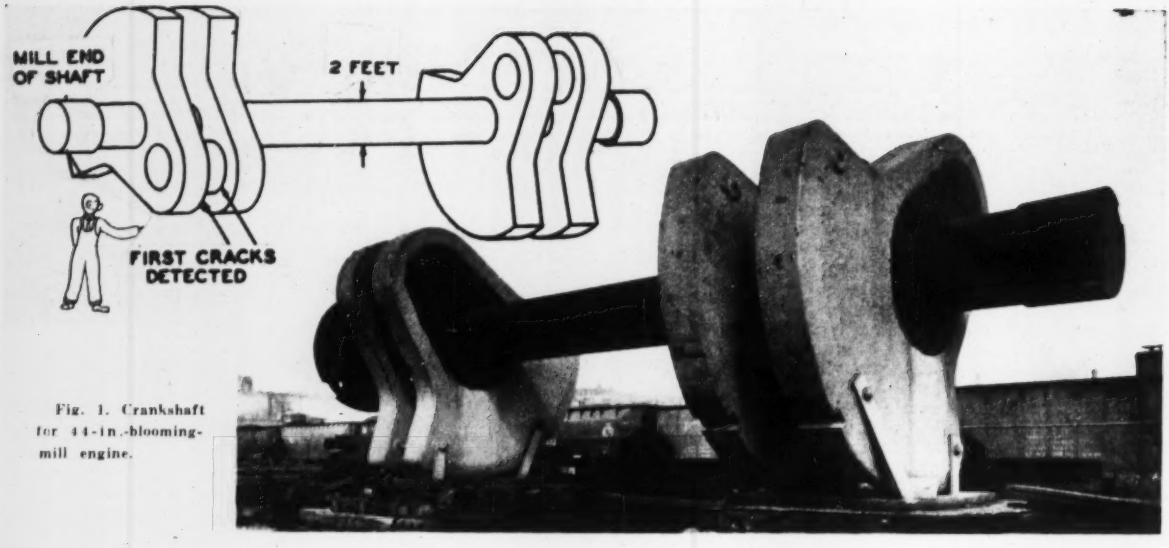


Fig. 1. Crankshaft for 44-in.-blooming-mill engine.

Special Instruments for the STEEL INDUSTRY

MORE and better instruments are needed constantly in the steel industry by inspectors, engineers of all types, mill operators and many other people connected with the business.

Ultrasonic Inspection

The Sperry "Reflectoscope" is an ultrasonic tester. Its original use in the steel industry in 1945 was for the inspection of gun blooms for internal defects. (Gun blooms are ingots in the early stages of rolling, preparatory to the manufacture of large gun barrels.) Before the introduction of the "Reflectoscope," the testing procedure was to cut off the end of each bloom. The length cut off was twice the thickness of the bloom; the piece cut off of a 10-in. bloom was 20-in. long. The 20-in. piece was cut off and scrapped. Then a thin slice was cut off for etching and macroscopic examination. Contrast this procedure with the "Reflectoscope" method. Passage of the ultrasonic crystal over the end surfaces of the bloom reveals the existence or absence of defects. In ten minutes, the inspector has a more complete, more reliable answer to his questions than he previously had had even after days of work and study. Scrap has been reduced, sawing labor on good product has been eliminated, laboratory expense has been reduced, inspection is more complete, and the customer is assured of a better product.

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

A Dramatic Incident

No maintenance man wants to leave a shaft in service when it is cracked half way through and can cause damage or loss of life when it breaks. Yet that is exactly what many maintenance men have been doing for years.

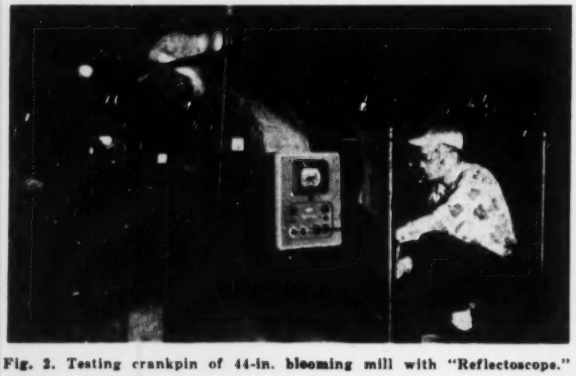


Fig. 2. Testing crankpin of 44-in. blooming mill with "Reflectoscope."

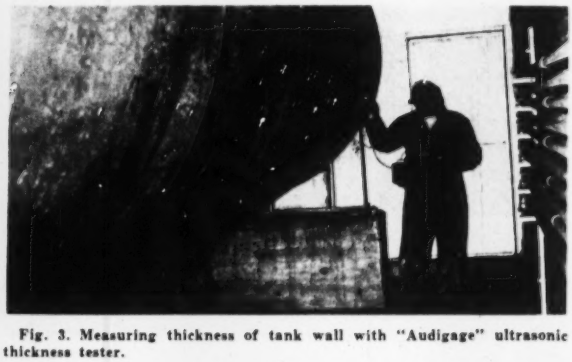


Fig. 3. Measuring thickness of tank wall with "Audigage" ultrasonic thickness tester.

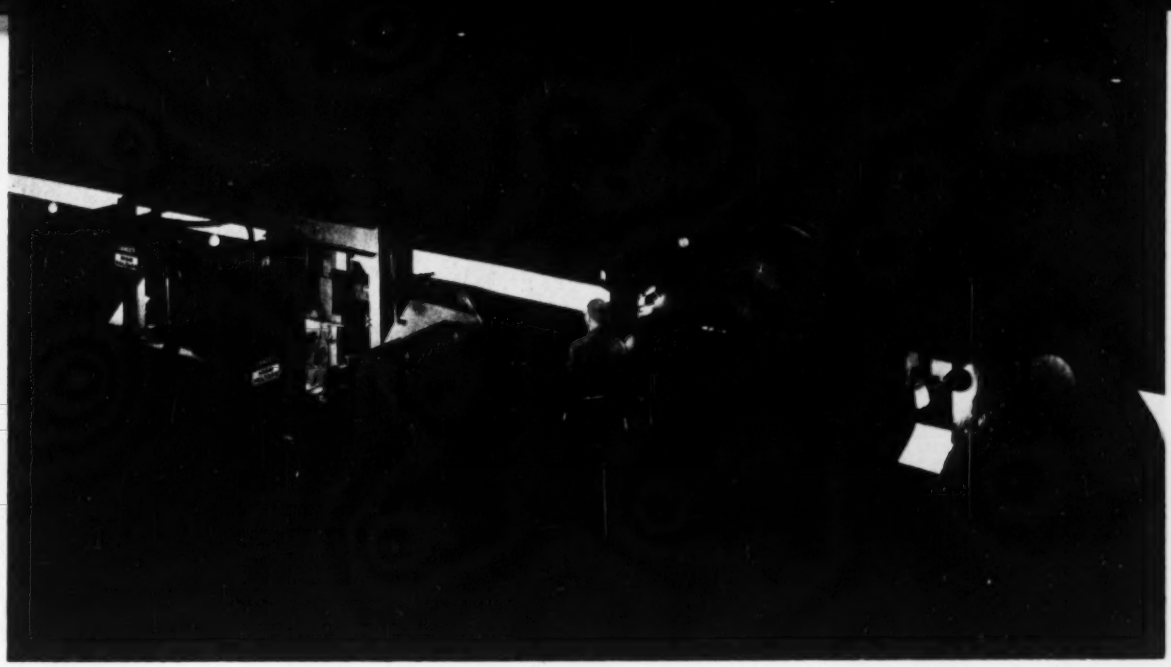


Fig. 4. X-ray "Measuray" gage on 98-in. hot mill.

W. A. BLACK

Republic Steel Corporation

Instrumentation is gradually transforming steel operations from an art depending on personal skill to a science depending on measurement and control. Examples show dramatic use of ultrasonic inspection and thickness gaging, x-ray thickness gaging, infrared width gaging, blooming-mill torque control with strain gages, open-hearth crane analyses with strain gages, and electrical weighing. Special depth and crack indicators have been developed.

Probably the most dramatic incident in the history of ultrasonic testing occurred in the Cleveland Plant of Republic Steel Corporation. It involved the discovery of internal cracks in a pin of the crankshaft of a 25,000-horsepower steam engine. The engine drives a 44-in. blooming mill. The crankshaft is shown in Fig. 1; the pin is 54-in. long and 24-in. in diameter. Breakage of the crank pins could have been catastrophic. The engine would probably have been destroyed. The blooming mill, locker room, men in the area, and an electrical substation were all vulnerable to the shower of flying steel propelled by super-heated steam at high pressure.

The maintenance crew had gone through their regularly scheduled Sunday inspection and—if they had not had the ultrasonic tester—would have declared the engine "O.K." Nothing appeared to be amiss even to their experienced eyes. Fortunately, they were prepared to make the ultrasonic test (Fig. 2), which discovered cracks in the pin. As the surface of the pin in the plane of the cracks (Fig. 1) was covered by the crank throw, the cracks were completely undetectable by any means except the ultrasonic method.

Thickness

It is frequently necessary to determine the thickness of tanks and pipes. The method commonly used is to drill a hole, measure its depth, and plug it up again. This method is slow, incomplete, and unreliable. The modern alternate is use of ultrasonic measurement.

If the material is ½-in. thick or more, the "Reflectoscope" can be used. Its lower limit of measurement is restricted by the difficulty of measuring the time interval between the broadcast of the high-frequency signal and the reception of its reflection or echo. For thicknesses below ½ inch, another ultrasonic method is used (Fig. 3). The wall of the vessel at the point being measured is vibrated at high frequency. The frequency is adjusted until the amplitude of the vibration is a maximum. That maximum is a function of the wall thickness, and the instrument is calibrated in terms of thickness. As the instrument measures only the distance from the surface to the first discontinuity the wave encounters, it can be used to detect laminations as well as to measure thickness.

Several manufacturers make instruments of this type. They include Sperry Products, Inc., Magnaflux Corporation, and Branson Instruments, Inc. Fig. 3 shows the Branson "Audigage."

X-ray Thickness Gage

The primary function of a hot-strip mill is to roll a slab down to a strip of a certain thickness. Until a few years ago, the roller had to depend on a micrometer measurement for information as to what thickness was being obtained. The measurement usually was made at one point near the corner of the strip—an infinitesimal percentage of the total area. This point differs from the actual over-all thickness of the strip more than does any other point on the strip. It is indeed a credit to the skill of the rolling-mill operators that they were able to hold the thickness as well as they did.

In 1947, by the use of the x-ray thickness gage (Fig. 4) hot-strip rolling took its place in the slowly moving parade of improvements that are gradually transforming steel operations from an art depending on personal skill to a

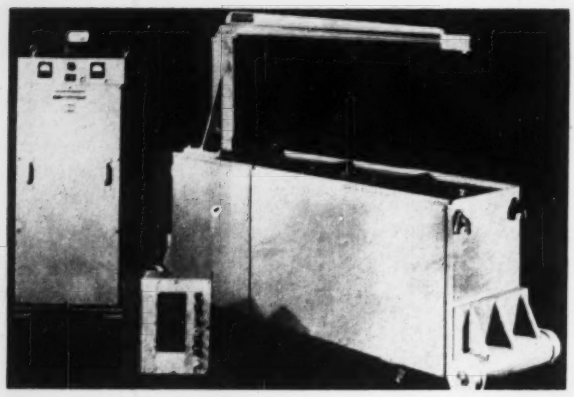


Fig. 5. "Measuray" x-ray gage.

science depending on precise measurement and control. The radiation-type gage measures the thickness of the strip without making contact with it. This permits continuous measurement of the thickness of hot strip. If the roller wants information on the variation across the width of the strip, he can make the gage traverse the strip.

The advantages of noncontacting gages include immediate and continuous thickness information, insensitivity to strip vibrations, higher accuracy on thin strip, reduced rejections due to instrument error, reduced waste of usable product, and others. Their use has now become so widespread that it can be said safely that the man who tries to operate a hot-strip mill without a noncontacting gage is reducing his yield and quality potential and endangering his prestige.

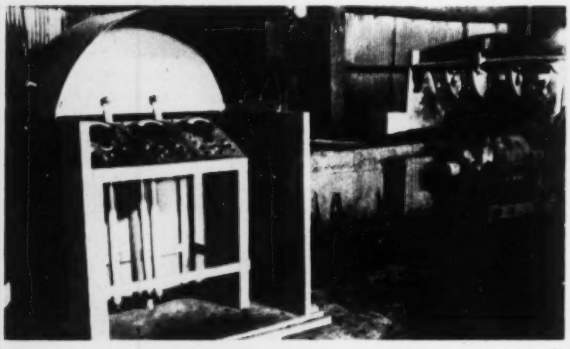


Fig. 6. Triple x-ray gage on plate mill.

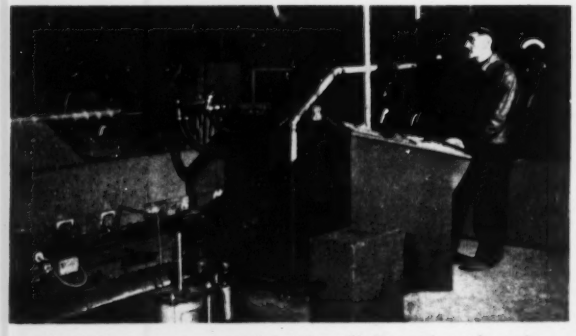


Fig. 7. X-ray gage on seamless tube mill for gaging tube ends.

The instrument used in the hot-mill installation of Fig. 4 is shown in Fig. 5. Extension of the use of such gages to cold strip has entailed the development of many designs. Fig. 6 shows a triple installation on a plate mill in a Republic Steel plant. The inspector's station is shown. The mill is at his left, the three gages are at his right.

The next step, now on trial, is automatic control of the roll position by the noncontacting gage. The many factors involved necessitate a cautious approach; all successful work to date has been on cold mills. Recent progress is encouraging. It is probable that in a short time, automatic control of roll position by the thickness indication of noncontacting gages will be accepted practice in strip mills.

An important by-product of the noncontact strip gage is the tube-end thickness gage (Fig. 7). The tube is rotated while the x-ray probe moves into the tube a distance of 6 feet. Wherever the wall thickness exceeds allowable tolerance, paint is sprayed on the outside. This mark guides the cut-off operator in trimming the pipe-ends. It also avoids scrapping salable pipe and provides the mill with prompt information regarding excessive off-gage material.

An instrument that is likely to be associated with the noncontacting thickness gage on hot strip mills is the noncontacting width gage. The scanning unit, about 12 feet above the strip, scans the strip for infrared radiation. It is a highly sensitive device whose output is used to record the width on an instrument at the rollers' control station.

Stress, Strain, Torque

The next group that is increasing attention in instrumentation is the stress, strain, and torque estimate group. In this field, the best of engineers is liable to stumble because of lack of measured data and the necessity to estimate or assume values that cannot be checked. The device that has proven fundamental in this work is the SR-4 strain gage. Instrumentation that can be used with it is almost unlimited in variety and extent. A few applications show how important a part it can play in steel-mill operations. One application is the determination of torque on the spindles connecting the 44-in. blooming mill with the engine mentioned in the ultrasonic test discussion; another concerns the measurement of load distributions, stresses, and strains in open-hearth crane girders and columns.

Blooming-mill Torque Control

Fig. 8 shows the entry side of the 44-in. blooming mill. In the past, assumptions made in the absence of actual measurements had resulted in production loss and high maintenance cost. One popular explanation for the frequent failures was that the roller tried to roll ingots that were not as hot as they should be.

Owing to repeated breakages of the lower drive spindle, torque on that spindle was an important variable. It was also elusive. Torque depends on several elements including roll pressure, coefficient of friction at various points, compression area in the ingot during rolling, and bearing conditions. To calculate actual torque values during rolling would be an engineer's nightmare, but strain gages (Fig. 9) permit direct measurement.

In a project involving massive equipment and many variables, it is essential to plan carefully the exact location of the strain gages, the design and construction of the slip rings, the accumulation of associated data, the coordination of observations, and, above all, the analysis and interpretation of the data. The variables that had to be measured were (1) torque of both top and bottom spindles, (2) mill housing load, (3) pass height, (4) reduction per pass, (5) roll speed, and (6) ingot temperature. The in-

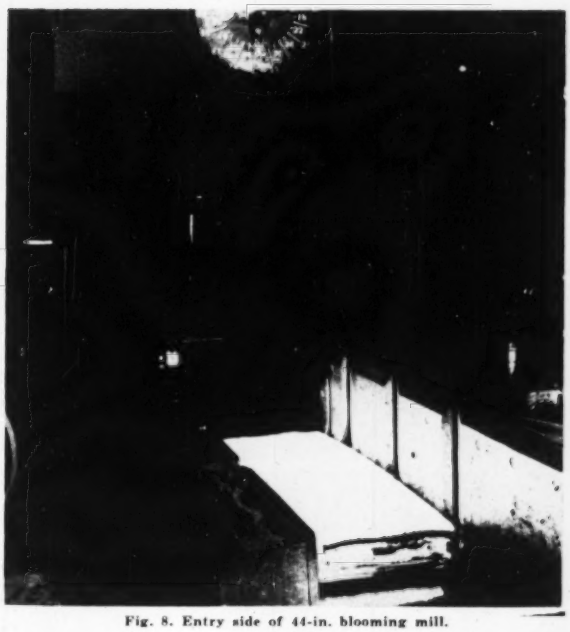


Fig. 8. Entry side of 44-in. blooming mill.

Fig. 9. Strain gage, showing small size.

Fig. 10. Instruments used in 44-in.-blooming-mill tests.

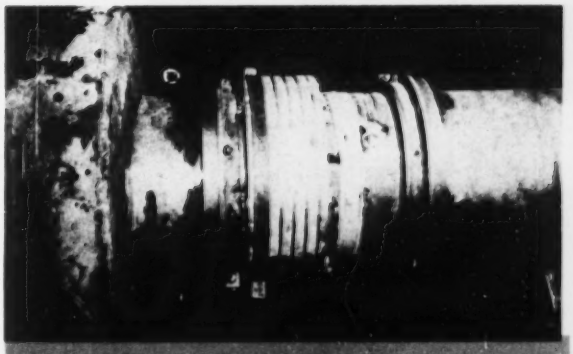


Fig. 11. View of strain gages and slip rings mounted on 44-in.-blooming-mill spindle shaft.

Fig. 12. Typical torque record during one pass on 44-in. mill.

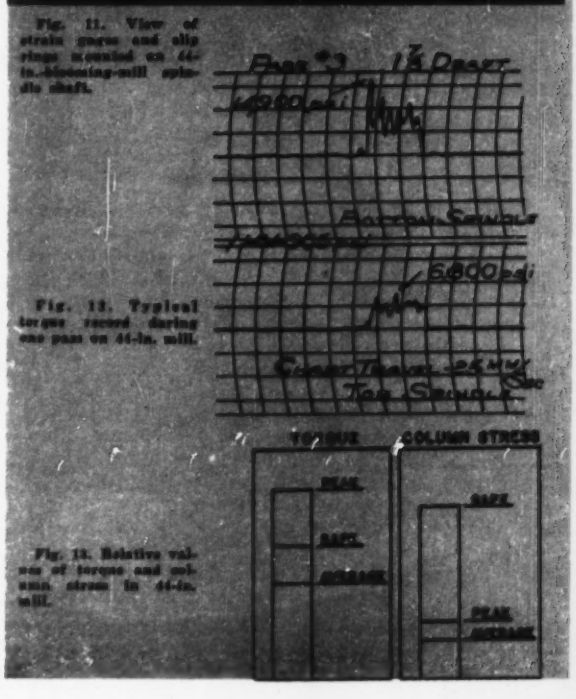


Fig. 13. Relative values of torque and column stress in 44-in. mill.

struments used (Fig. 10) were located in the engine room, remote from the vibration and dirt of the mill. Phone communication was used between the observers in the mill and those at the instrument locations.

The strain gages and slip rings can be seen on the shaft in Fig. 11. This assembly was water-proofed and then covered with a rugged protective cover. Fig. 12 is a typical recording of the torque during one pass. The bottom spindle reached a peak strain of 14,900 psi. while the top one reached a peak of only 6,300 psi. These figures correspond to torques of twenty million lb.-in. and nine million lb.-in., in the bottom and top spindles respectively.

Conclusions derived from data:

1. 30 percent of the peak loads exceeded the endurance limit of the shaft. This means that maintaining the peaks at the normal frequency of the mill would result in breakage of the shaft.

2. *Average* spindle torque and average mill housing column stresses were well within safe operating limits (Fig. 13). This means that failures were caused not by a high sustained torque, but by high peak loads at a high frequency of operation.

3. Not only the average but also the peak loads on the *mill housing* were well within safe limits (Fig. 13). The peak reading in this chart is the highest reading obtained during the rolling of 20,000 ingots. It is so far below the capacity of the housing that the possibility of overdesign is indicated.

4. Contrary to expectations, the mill housing pressure was not proportional to the torque on either spindle or the total torque on both spindles. As it is easier to measure housing pressures than torque, it was hoped that housing pressures could be used as a measure of torque. The scatter of data reveals that any housing stress measurement could correspond to a wide range of torque values.

5. The fact that certain operators consistently overloaded the mill more frequently than others indicated an element of skill in mill operation.

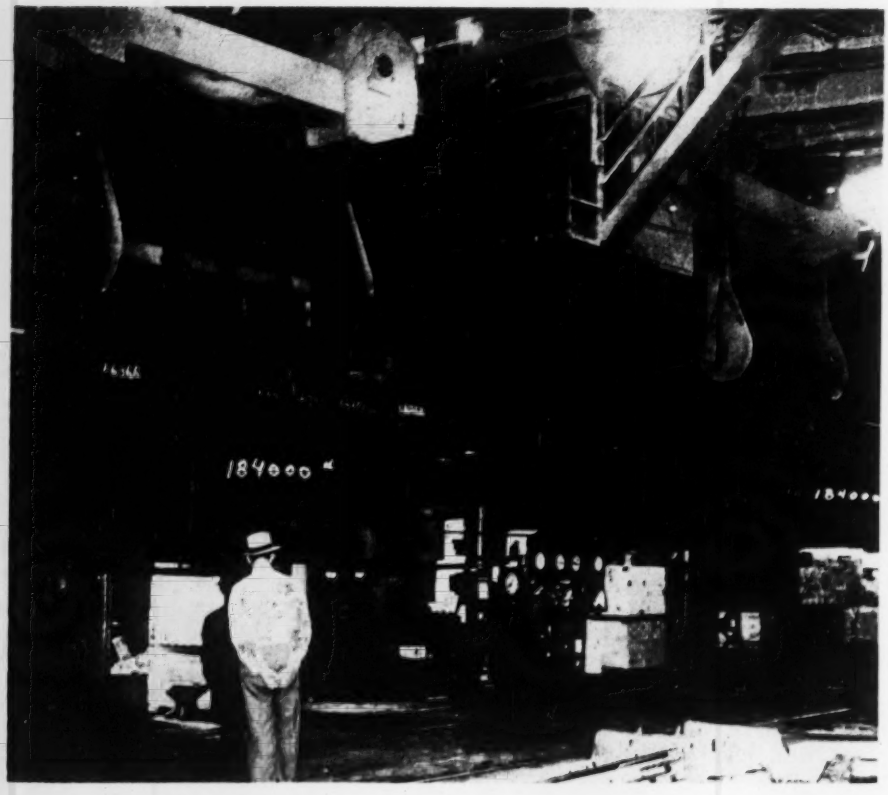


Fig. 14. Strain-gage studies in progress for determining stresses in open-hearth crane runways.

6. The figures indicated the possibility of using torque measurement as a means of avoiding overload and also as an aid in maintaining mill capacity. If the mill could be loaded to full safe capacity in each pass, the increase in production would probably be much greater than that gained by the occasional heavy drafts which caused the overload peaks.

7. Even though low temperature in the ingot tended to increase the loading on the mill, no direct relationship was established between temperature and high torque. Other factors affected the torque enough so that temperature was far from being the dominant influence.

Open-hearth Crane

Work on the open-hearth crane girder and columns was prompted by the fact that large expenditures were contemplated to increase the capacity of the crane. Theoretical assumptions regarding loads, capacity of the girders, and column deflections led to an estimated cost which was in excess of the amounts that the management felt justified. The engineers then used strain gages to get actual measurements of load distribution, strain, stress, etc.—with satisfactory results. Fig. 14 shows some work in process. Since the first project of this kind was completed about 3 years ago, similar work has been done in other plants of Republic Steel Corporation; the study of open-hearth cranes has altered plans sufficiently to reduce the anticipated cost by several hundred thousand dollars. One project would have been abandoned if strain gages had not revealed that it could be done for a fraction of the original estimate.

Seam-depth Indicator

"Mistakes" in estimating the depth of seams in steel plants total many thousands per day. Inspectors are sometimes expected, for instance, to pass seams less than 1/32-in. deep, but must reject seams more than 1/16-in. deep. If they try to use a file and a depth micrometer, they face an endless task; visual examination is not adequate.

A solution was developed in the Electrical Laboratory of Republic Steel Corporation, Cleveland. It is the Seam-depth Indicator (Fig. 15), shown being used as a "go-and-no-go" gage on billets with a maximum passable seam of 0.030 inch. Couplings also can be inspected to allow a maximum seam depth of 0.030 inch.

In operation, the seam-depth indicator passes or rejects seams by movement of a search coil across the seam. A high-frequency current in the coil induces a similar current in the surface of the piece being tested. The coil also detects changes of conductivity in the surface. Conductivity is roughly proportional to seam depth and can, therefore, be used as a measure of seam depth. If the seam is deeper than a predetermined value, a light flashes in the handle of the detector-coil assembly.

An automatic coupling inspector has been developed which cleans, inspects, and cleans or rejects, all automatically.

A direct-reading instrument also was designed and built. It indicates seam depth in thousandths of an inch. Owing to the instrument's sensitivity to conductivity, it must be calibrated for the conductivity of the material being inspected.

The seam-depth indicator has also proved its worth in maintenance operations. A good example is the inspection of a boiler in one of Republic's plants. Because of his discovery of several cracks in the inside of a large tank, the insurance-company inspector rejected the tank. If this rejection had been final, production of a mill would have been stopped for weeks. Fortunately, a seam-depth indicator was available. Its accuracy was demonstrated to the inspector by measuring the depth of several cracks and then grinding them out. On the basis of this demonstration, he authorized complete inspection of the tank; upon finding that all of the cracks were superficial, he permitted its use.

Fig. 15. Testing billets with seam-depth indicator.

Fig. 16. Republic crack-detector for locating flaws in welded tubing.

Crack Detector

Related to, but different from, the seam-depth indicator is another development of Republic's Electrical Laboratory, —the Crack Detector (Fig. 16). It is an inductive method of defect detection and has been used exclusively on tubing. It consists merely of a single coil, a control panel, and a signal light.

In addition to its simplicity and easy installation, this instrument has an important feature seldom found in induction-type defect-detecting equipment—it has no appreciable end-effect; it will detect the defect even on the end of the tube. Short pieces of welded tubing suspected of incomplete welds at the ends can be inspected rapidly for that condition.

Weighing

Weighing is an operation in which the steel industry condones a large volume of honest "mistakes." Dependence upon "estimated weights" is concentrated principally in interdepartment weighing, presumably on the assumption that errors in one department will be counteracted by compensating errors in another department.

The Republic Steel Corporation Electrical Laboratory has concentrated on the application of strain-gage scales (Fig. 17) for locations which cannot be served economically or efficiently by conventional scales. As scales are

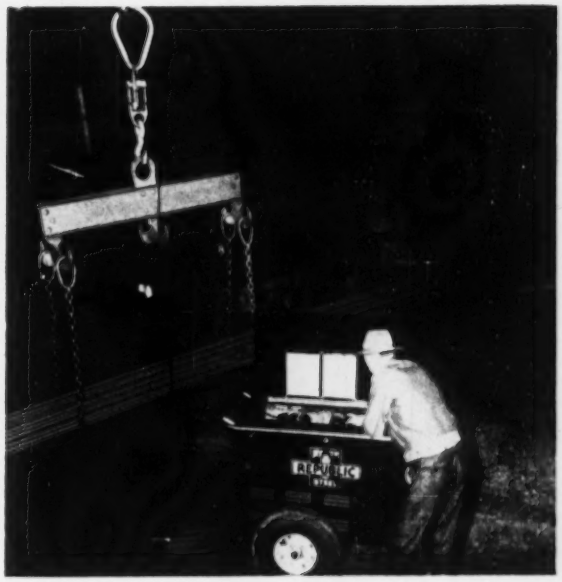


Fig. 17. First portable 50,000-pound crane scale in the steel industry. The scale can be used wherever a crane is available; one use has been to check accuracy of mill scales.

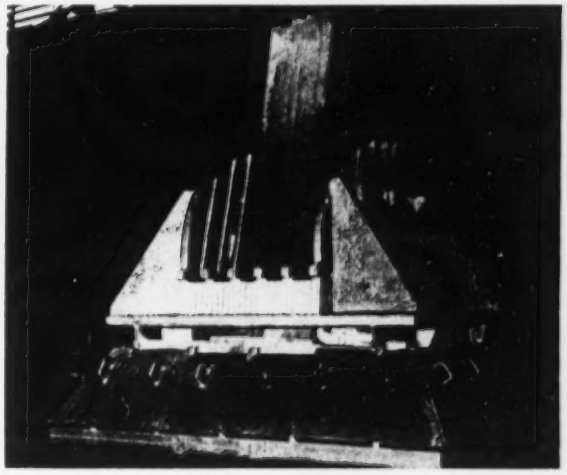


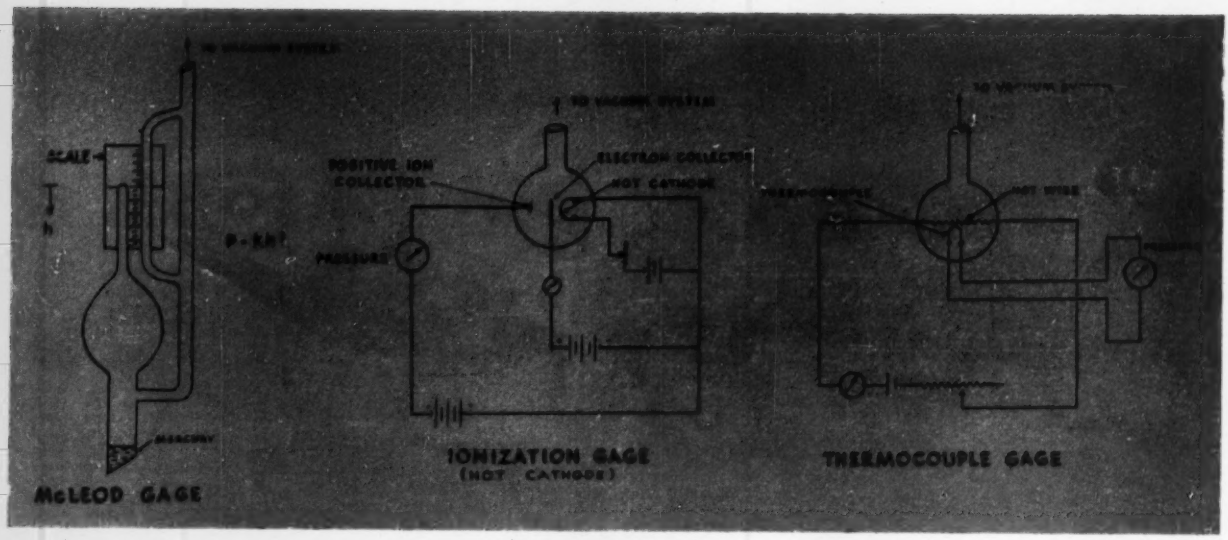
Fig. 18. Scale for weighing hot ingots.

adapted to automatic use and control applications, their role in steel production will be enlarged.

Another crane scale has been developed which is believed to be the first built-in electrical scale with high accuracy, multiple cells, and a spreader beam especially designed to accommodate electric weighing equipment without any loss of headroom.

A basket-like structure (Fig. 18) is used for weighing hot ingots. Even though it is frequently subjected to the terrific impact of 10-ton ingots dropping from a considerable distance, the platform is kept in the weighing position at all times. It has been in service since October, 1951 despite the punishment inflicted by dropping ingots.

The groundwork laid by experience with these and other electrical scales provides a basis upon which a program of automatic recording and automatic control can be built. The applications described of special electrical instruments that have found a place in steel operations illustrate the vast possibilities.



Measurement Technique for

HIGH VACUUM

Two basic types of data are required in vacuum measurement—(1) mean-free-path, or collision-type, data and (2) number of gas molecules, or pressure-type, data. Choice of proper vacuum gage depends on the data required, and on range, cost, reading method and accuracy.

KENNETH ROACH
Process & Instruments

HIGH-VACUUM TECHNIQUE is important in many manufacturing processes. As the term "high vacuum" has several connotations, we shall define high vacuum as the condition existing when the *mean free path* (distance travelled between collisions) *of gaseous molecules present is greater than the dimensions of the defining elements of the vacuum system.*

High vacuum is used in devices (receiving tubes, cyclotrons, etc.) and in processing of materials; vacuum processing is being applied widely to distillation and drying of high-molecular-weight compounds, and in vacuum fusion of metals. Measurement of the degree of vacuum (pressure) is of basic importance, and many devices have been developed to measure the vacuum.

Gas Sources

Sources which prevent the attainment of a "good" vacuum include: (1) residual air, (2) air leakage, (3) vapor pressure of material in system, (4) desorbed gases and vapors from surfaces, and (5) reaction products.

One or more of these sources contribute to the total gaseous content of the system. It should be emphasized that, as the residual and inleaking air of a system is reduced, the effect of desorbed vapors becomes proportionately greater. Water, light organic molecules, and some gases (CO, CO_2, SO_2, Cl_2, H_2) which are absorbed strongly on surfaces are the usual offenders. To reduce this source of pressure, the vacuum system may be *outgassed* by heating, or cleaned-up with chemical "getters" or electrical discharge. Another source of pressure that often is overlooked in vacuum systems is the vapor pressure of vacuum-pump fluids or oils, and of vacuum lubricants. The use of low-vapor-pressure oils and greases, and use of cold traps or traps containing absorption materials will reduce the gaseous contribution from these sources.

Once the sources of molecules giving pressure indication in a high-vacuum system are known, the problem is to choose the gage best suited to the system and process.

Classification of Gages

Vacuum gages may be classified in two broad groups—namely, those performing (1) a true pressure measurement of force exerted by molecules on an area (liquid or diaphragm), or (2) an indirect measurement of pressure by correlation of the number of molecules present (pressure) in the high-vacuum system with various properties of the gases—thermal conductivity, viscosity, ionization.

The following chart lists a few of the commonly used vacuum gages, their principle of operation, range, and characteristics.

Information Required

Proper choice of gage depends on the information required, which may be either (1) number of gas molecules per unit volume of system or (2) number of collisions of gas molecules and other particles between elements in the system. The former is the value indicated as pressure by vacuum gages; the latter is the information most often

required in high-vacuum work. Unfortunately, the former (the vacuum-gage reading, which is a measure of the pressure of pumpable gases) is usually insufficient to predict the number of collisions of molecules and particles in the space between elements of the system. For example, in an electron tube containing a plate and cathode, it is necessary to know the number of collisions between molecules and charged particles in the space between the cathode and the plate. Maintaining the pressure constant in the system and moving the plate closer to the cathode decreases the total number of collisions of molecules and particles in the space between the plate and the cathode. Thus a measure of pressure as well as of distance between elements and of number of charged particles is required.

Mean-free-path Measurements

Knowledge of the *number of collisions of gas molecules in the system* is the information most often required in high-vacuum work.

Example 1: A measure of residual and inleaking air is desired to determine whether distillation and recovery of a substance with a low vapor-pressure is feasible. Furthermore, the substance may be sensitive to oxidation or heat. In such cases, lowering the air pressure decreases the number of collisions of the distillant with air. The same objective (decreasing number of collisions of distillant with air) is attained by decreasing the distance through which the distillant molecules must travel.

Example 2: A measure of the gaseous molecules that may interfere with the passage of particles carrying electrical charges (as in electron vacuum tubes and particle accelerators) may be required. The pressure indication is primarily to inform the engineer when the molecular concentration between elements is low enough to permit passage in the particular system without scattering of the charged particles.

Example 3: A measure of the pressure of gases which can be evacuated from a system may be required, as in vacuum coating. The pressure reading informs us when to start evaporation of molecules; changes in the reading indicate changes in concentration or mean free path (distance travelled between collisions) of the gas between evaporator and coated film. The number of collisions between gases and evaporated metal must be kept lower than a fixed value which is determined by the gaseous content of the system, the rate of evaporation of metal, and the dimensions of the system. The final determinant is the result obtained in the coated film.

Thus, when *number of collisions of molecules between elements* is the variable of interest, the vacuum measurement serves only as a convenient guide for setting limits within which to operate. Any gage having the desired range and convenience of operation can be used for this type of measurement. The gage should be protected from vapors and metal deposits which may contaminate its surfaces.

It is not necessary to have absolute and accurate pressure readings in such operations. Once the optimum operating conditions are established, the reading of the gage should be observed and deviations from this value used as a guide to operation. The pressure measurement itself may be inadequate for evaluation of the number of gaseous collisions in the space between elements in the system, and additional independent data for checking the pressure between elements or mean free path may be used. For example, in Example 1 above, the degree of separation of components by molecular distillation depends not only on the pressure of evacuable gas present but also on the rate of heating of the distillate. Thus the rate of heating or rate of distillation can be used as additional measurements for keeping the mean

Table.—Principles and Characteristics of Common Vacuum Gages.

Basic class	*Operating Principle*	*Gages*	*Pressure Range mm.Hg* 10^{10} 10^{9} 10^{8} 10^{7} 10^{6} 10^{5} 10^{4} 10^{3} 10^{2} 10^{1} 10^{0} 10^{1} 10^{2}	*Characteristics* Absolute manometer	Sens. to gas composition	Continuous reading	Rugged	Moving parts	Electrical parts	Optical parts	Easily contaminated
Measures Force of Molecules on an Area	Liquid Displacement	McLeod	X X X X X X X X	Y	Y	O	S	Y	O	S	Y
		U-tube manom., oil	X X X	Y	Y	Y	S	Y	O	S	Y
		U-tube, Hg—Rayleigh	X X X X X	S	Y	S	S	Y	O	Y	Y
	Radiometer—transfer of momentum from hot to cold surface	Knudsen	X X X X X X	S	Y	Y	O	Y	O	Y	S
	Mechanical manometer. Deformation of thin wall by pressure	Diaphragm micromanometer	X X X X X X	S	Y	Y	S	Y	Y	O	O
		Quartz spiral	X X X X X X	S	Y	S	O	Y	O	Y	O
Measures Property of Gas in Terms of Pressure	Heat conductivity—cooling of wire by gas	Pirani	X X X X X	O	O	Y	Y	O	Y	O	S
		Thermocouple	X X X X X	O	O	Y	Y	O	Y	O	S
	Viscosity—transfer of energy between molecules and surfaces	Viscosity—decrement	X X X X	O	O	O	O	Y	O	Y	O
		Viscosity—static	X X X X	O	O	Y	O	Y	Y	Y	O
	Ionization—gases ionized by electron or alpha-particle impact	Hot filament	X X X X X X X	O	O	Y	S	O	Y	O	Y
		Cold cathode (Philips)	X X X X X X X X	O	O	Y	Y	O	Y	O	S
		Alphatron	X X X X X X	O	O	Y	S	O	Y	O	S
		Mass spectrometer	X X X X X X X X	S	O	Y	O	O	Y	O	Y

Y — yes
S — sometimes
O — no

free path of the combination of distilled molecules and evacuable gases within desired limits.

Pressure Measurements

A knowledge of the *number of gas molecules per unit volume (pressure) in a system often is required:*

Example 1: A measure of degree of outgassing or drying of a material in a high-vacuum system is often desired. Here the significant measurement is the determination of the number of gaseous molecules evolved per unit time, or the total number evolved. High vacuum is usually necessary because the material being treated may be heat sensitive (such as biological fluids) and therefore cannot be dried by more conventional methods.

Example 2: A measure of gases evolved in reaction studies and desorption of surfaces is required. Also, the calibration of gages by determining either the total gaseous content or the ratios of different gaseous components in the system may be of importance.

In using gages to determine molecular concentration, information is usually necessary about the source of pressure and also the characteristics of the measuring gage (see chart of gages). As the gage reading must be a direct measure of the molecular concentration, care should be taken to minimize changes in calibration of the gage during use. Materials that often cause changes in calibration of gages are corrosive gases, oxygen, chlorinated compounds, and organic compounds which react with elements of the gage. Elements of the gage itself can decompose materials in the vacuum system—organic compounds are decomposed by hot-filament and ionization gages.

Thus the choice of a gage for measurement of molecular concentration depends on how the gage reacts with the material in the system. For materials which are changed easily by the addition of energy (heat from a hot filament or electron-beam impact) a gage should be chosen that imparts the least energy to the molecules present. For example, the use of a thermocouple or Knudsen (low-temperature) instead of an ionization (high-temperature, electron-beam) gage is indicated.

The vacuum engineer must consider not only changes in calibration arising from chemical reaction with the gage, but also the change in sensitivity of many gages with change in gas composition. Vacuum gages that measure a property of the individual type of molecules (heat conductivity, ionization, and viscosity gages) must be calibrated for each different gas. Thus in a system with changing gas composition it may be necessary to use an absolute-type gage (McLeod, diaphragm, or Knudsen) if one is interested in accurate measurement of molecular concentration.

Owing to the difference in sensitivity of some gages with different gases, the vacuum engineer often can measure ratios of constituents (i.e., perform gas analysis) by using multiple gages with reaction chambers or absorption traps. An example is the determination of water concentration in a low-pressure gas stream by measurement of thermal conductivity (Pirani) of the total gas stream, then reduction of the water to hydrogen gas and measurement of the conductivity of the final gas mixture. The *change* in thermal conductivity will be a function of the water content of the gas.

Another effect to consider when measuring pressure in a system (molecular concentration) is the clean-up (absorption) of some gases by ionization gages. This and the more common tendency of gages to outgas and thus contribute gas to the system, makes absolute readings of molecular concentration suspect in high-vacuum systems.

The ideal instrument for measuring molecular concentration in a high-vacuum system is the mass spectrometer. The mass spectrometer can follow the concentration of specific components of the gas in the system and usually enables the operator to trace the source of pressure.

Choice of Gage

Once the purpose for measuring the vacuum (number of molecules per unit volume or number of collisions of molecules between elements) has been decided upon, the selection of the proper gage then depends on:

1. *Range*:

For pressures above 10^{-4}mm. Hg the McLeod, diaphragm, thermocouple, Knudsen, Pirani, Alphatron, or cold cathode (Philips) ionization gages may be used. For pressures below 10^{-4}mm. Hg the ionization-type gage or sensitive Knudsen are required. The Philips and Knudsen gages are available with an extended range from 10^{-8} to 10^{-2} mm. Hg.

2. *Cost of Gage*:

In general, the lower the pressure measured the higher the cost of the gage and auxiliary equipment.

3. *Method of Reading*:

Method of indication of the pressure may be a determining factor. A manually-operated McLeod gage gives a discontinuous reading; the operator must trap and then compress a sample of gas to make a measurement. Where a continuous reading is required, as for control use, an electronic gage (ionization, Pirani, or thermocouple) or a "turbine" type viscosity gage may be required.

4. *Accuracy*:

The accuracy of vacuum measurements must always be considered with suspicion—if the pressure indication is assumed to come from one source. Readings of air being evacuated are often complicated by desorbed vapors from the gage or vacuum system. For accurate readings and calibration of gages, absolute gages (McLeod or U-tube manometer) should be used. All condensable vapors should be trapped from the gages being calibrated and the system thoroughly outgassed. Only in this manner can accurate calibrations be obtained.

5. *Ruggedness*:

In general, vacuum gages are delicate instruments that require care in handling and using. The most rugged, wide-range vacuum gage presently available is the cold-cathode (Philips) gage; there is no filament to burn out and, in the metal-type version, no glass envelope to break. The McLeod gage and other types are also available in ruggedized industrial models.

The choice of a vacuum gage, therefore, should be such as to supply the specific information required for the successful operation of the particular high-vacuum process at a cost consistent with the value received.

Bibliography

1. Dushman, *Scientific Foundations of Vacuum Technique*, Wiley, 1949.

2. Yarwood, *High Vacuum Technique*, Wiley, 1945.

3. Farkas & Melville, *Experimental Methods in Gas Reactions*, Cambridge, 1939.

4. Daynes, *Gas Analysis by Measurement of Thermal Conductivity*, Cambridge, 1933.

5. Strong, *Procedures in Experimental Physics*, Prentice-Hall, 1939.

6. Guthrie & Wakerling, *The Characteristics of Electrical Discharges in Magnetic Fields*, McGraw-Hill, 1949.

7. Guthrie & Wakerling, *Vacuum Equipment and Techniques*, McGraw-Hill, 1949.

8. *Vacuum*, W. Edwards & Co., London.

9. Burrows, "Color of Electrical Discharge," *Journal of Scientific Instruments*, Vol. 20, p. 21, 1943.

10. Johnson & Harrison, "Manometers," *Journal of Scientific Instruments*, Vol. 6, p. 305, 1929.

11. Alpert et al, "Manometers," *Review of Scientific Instruments*, Vol. 22, 1951 p. 370.

12. Barr & Anhorn, "McLeod Gauge," *Instruments*, Vol. 19, p. 666, 1946.

13. Flosdorf, "McLeod Gauge," *An. Ed., Industrial & Eng. Chemistry*, Vol. 17, 1945, p. 198.

14. "Electronic Diaphragm Micromanometer," *NBS Technical News Bulletin*, Vol. 34, 1950, p. 137.

15. Steckelmacher, "Knudsen Gauge," *Vacuum*, Vol. 1, 1951, p. 226.

16. Ubisch, "Pirani Gauge," *Analytical Chemistry*, Vol. 24, 1952, p. 931.

17. Guthrie & Wakerling, "Vacuum Equipment and Techniques" pp 117 ff (Ioniz. Gauge)

18. Evans & Burmaster, "Cold Cathode Gauge," *Proceedings of the IRE*, Vol. 38, 1950, p. 651.

19. Downing & Mellon, "Alpha Particle Gauge," *Rev. Scient. Instruments*, Vol. 17, 1946, p. 218.

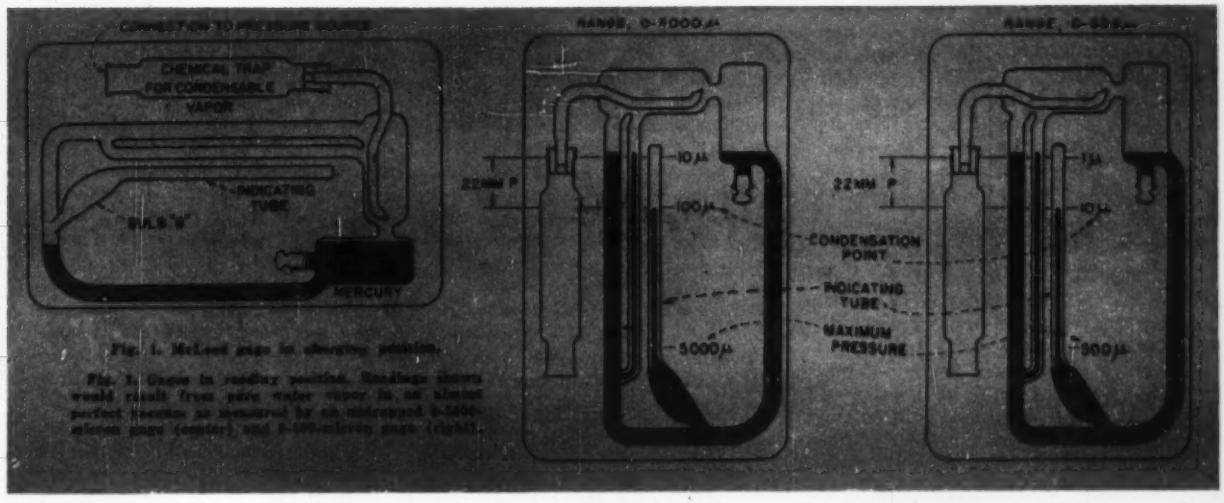


Fig. 1. McLeod gage in charging position.

Fig. 2. Gages in reading position. Readings shown would result from pure water vapor in an almost perfect vacuum as measured by an unbranched 0-5000-micron gage (center) and 0-500-micron gage (right).

The High-vacuum Standard--

THE McLEOD GAGE

Oldest of the methods for accurate measurement of high vacuum, the McLeod gage is still the standard instrument by which other types are calibrated, and is increasing in importance as high vacuum comes into wider use in process industries.

EARL W. FLOSDORF

F. J. Stokes Machine Company

McLEOD VACUUM GAGE directly measures vacuum (pressure) by sampling a small amount of the rarefied atmosphere in the vacuum system and compressing it to a smaller volume at a higher pressure. It is the only direct-measuring type of gage suitable for accurate absolute measurement; developed in 1874, it is still the basic standard for such measurements.

All other gages for the measurement of high vacuum are based on some property of the vacuum system not related to the basic pressure-volume principle attributed to Boyle. Accordingly, all these other gages must be calibrated periodically against a McLeod-type gage, which is the ultimate reference standard.

The McLeod gage can be used over a wide range of vacuum—from a fraction of a micron up to 50 millimeters of Hg. It does not require any supply of electricity, is rugged, and can be used directly for all ordinary vacuum measurements.

With the ordinary McLeod gage, noncondensable gases other than air cause no error in the reading, whereas condensable vapors such as water or alcohols can cause serious error. However, a built-in chemical trap can eliminate this source of error.

Principle of Operation

The McLeod-type gage operates on the pressure-volume principle established by Boyle. A fixed volume (V) of the rarefied gas in the vacuum system at an unknown pressure (P) is trapped in the gage with mercury by tilting it from the horizontal charging position (Fig. 1) to the vertical reading position (Fig. 2). This trapped gas is compressed by rising mercury to a smaller volume (v) in the center indicating tube (C) at a higher pressure (p). It can be seen that V is the combined volume of measuring bulb B and center tube C, which is a closed-end tube, or measuring capillary. The value of p is equal to the difference in level of the mercury in the center indicating tube C and the right-hand outside tube, or compensating capillary. Boyle's Law is used in calibrating the scale.

An electrical measuring system which changes resistance in accordance with changes in mercury level can be used to indicate the height of the mercury in the measuring tube. A recording potentiometer can be used to indicate and record this resistance in terms of pressure. With a high-speed continuous-balance recorder, the sampling-measuring cycle time of the gage is reduced so that an almost continuous record can be obtained.

Water-vapor Effect

During compression, the pressure-volume relationship of Boyle applies only to noncondensable gases. With condensable gases (like water vapor) there is much greater contraction because such gases withstand only a small degree of compression before condensing (at normal gage temperature). If the pressure p exerted on the vapor trapped in the center tube exceeds the

condensation pressure (which varies with temperature), the vapor will condense. As a result of the greater contraction in volume in the center tube from this cause, the mercury will rise farther and indicate a higher vacuum than actually exists. There is no correction or multiplication factor that can take account of this.

Fig. 2 (center and right) shows two gages, one having a range of 0 to 500 microns and the other 0 to 5000 microns. Both gages have about the same scale length and are connected to the same vacuum system. If the gages do not have chemical traps, different readings will be obtained if water vapor is present, but neither will be correct. The difference in level of the mercury contained in the two capillaries creates a pressure that condenses the trapped moisture. At a temperature of 24 deg. C. the vapor pressure of water is 22 mm. In other words, if the difference in level of the mercury in the two capillaries is 22 mm. or more, the vapor will be condensed. This point on the measuring capillary (corresponding to the difference in level which is equal to the vapor pressure) we may call the *condensation point.*

In the narrow-range gage (0 to 500 microns), the condensation point corresponds to a pressure indication on the scale of about 10 microns; on the wide-range gage, to about 100 microns, as indicated in Fig. 2. Consequently, if the sample is largely water vapor, say at a pressure of 250 microns, and little air, say at 2 microns, the vapor will condense to liquid (invisibly small in amount) and the contraction in volume will cause the mercury to rise in the measuring capillary of both gages to within 22 mm. of the top (the vapor pressure of condensed water) plus a small amount due to the 2 microns of air (see table). The narrow-range instrument will indicate a pressure of 23 microns, and the wide-range one will indicate 120 microns. In this example, the total pressure of air and water vapor combined is 252 microns, which is far above 23 or 120 microns. All the operator knows, however, is that the *pressure of the air alone* is not over 23 microns, because, if it were, it would prevent the mercury from rising so high in the 0-500-micron gage.

When the air pressure is above 100 microns, the two untrapped gages would come into closer agreement (though still not exactly identical readings); both readings still would be in error. For example, at 24 deg. C. a sample with air pressure of 100 microns and a water vapor pressure of 1,500 microns yields a total pressure of 1,600 microns. With the wide-range scale, p would comprise 22 mm. of length for the compressed air plus another 22 mm. for the partial pressure of water vapor under compression (which is at saturated conditions). This 44 mm. of scale length would indicate a pressure of 450 microns. Similarly, with the narrow-range scale (0 to 500 microns), p would comprise 51 mm. for the air and the same 22 mm. additional for the water vapor, a total length of 73 mm., thus indicating 200 microns. Both gages would give these same readings (which are incorrect) even if the actual pressure were as high as 5,000 microns—if 100 microns of this total pressure were due to air and the remaining 4,900 microns to water vapor. By contrast, with 100 microns of air pressure and 150 microns of water vapor (a total of 250 microns), the wide-range gage would read correctly because the total pressure is below 450 microns and, accordingly, the partial pressure of the compressed water-vapor in the capillary is less than 22 mm. The narrow-range instrument would read 200 microns, which is incorrect.

Drying the gases will correct such errors. A dry-ice or liquid-air trap can be used, but is inconvenient.

Chemical Trap

A built-in chemical trap provides the simplest method of protection against condensation errors, and permits measurement of the correct total pressure, including water vapor. It makes use of a glass tube large enough in diameter to cause no undue restriction to the flow. The tube is filled with a chemical selected as having a vapor pressure well below the minimum pressure to be encountered in the high-vacuum system. This prevents vapor from entering the gage. By suitable choice of chemical, vapors other than water (such as alcohol and oil, which cause errors similar to those caused by water vapor) can be trapped. An indicator chemical can indicate when the trapping agent must be replaced.

The chemical trap causes true total pressures, including that of water vapor, to be indicated—not just the pressure of noncondensables only. Although there is only dry air in the indicating tube at all times, this air is present at a pressure which exactly balances the *total pressure of condensable vapor and air* in the system on the other side of the trap. This has been proved by measuring the vapor pressure of ice at various known temperatures under experimentally accurate conditions.

At total pressures below the condensation point, condensation cannot occur and accurate readings are obtainable. Water vapor originating in the glass or mercury in the gage, however, may not be pumped away completely enough to establish equilibrium with the system, in which event a fictitiously high reading will be obtained. Generally, this occurs at pressures below 10 microns, but by drying the gages this type of error can be avoided. The McLeod gage with a vapor trap automatically provides protection against this type of error.

In summary, the McLeod gage, after nearly 80 years, still remains the one and only type of instrument for measuring absolute pressure in a high-vacuum system reliably and directly, without reference to other gages for calibration. The chemical trap for condensables extends its usefulness for reading water vapor pressure.

Bibliography

1. McLeod, *Philosophical Magazine*, Vol. 47, 1874, page 110.
2. Flosdorf, Earl W., "A Simplified and Portable McLeod Gage," *Industrial and Engineering Chemistry (Anal. Ed.)*, Vol. 10, 1938, page 534.
3. Flosdorf, Earl W., U.S. Patents No. 2,278,195; 2,535,492; 2,542,076; and others pending.

Table—Effect of Water Vapor on Untrapped-gage Reading

Known Pressures			Untrapped-gage Readings*							
			0-500-micron model				0-5000-micron model			
Partial Pressures (microns), due to			Scale distance (mm.) due to			Pressure read (microns)	Scale distance (mm.) due to			Pressure read (microns)
Air	Vapor	Total	Air	Vapor	Total		Air	Vapor	Total	
2	250	252	7	22	29	23	1	22	23	120
100		250	51	22	73	200	22	12	33	250**
100	1500	1600	51	22	73	200	22	22	44	450
100	4900	5000	51	22	73	200	22	22	44	450

*With vapor trap, vapor is replaced by air so that pressure read is all cases agrees with known total pressure.
**With untrapped gage, this reading is not misleading with known vapor pressure.

Fundamentals of

ANALOG COMPUTERS

Analog computers solve differential equations by use of electronic integrators (rather than differentiators), adders and multipliers. The technique of linearization of a disturbance (perturbation) can be of use in process-control-analysis problems. A perturbation-equation analog solution is presented for a typical aircraft problem which, in essence, is similar to many process-control problems.

J. A. McDONNELL
International Business Machines Corporation

THERE are two general types of analog devices—inherent analogs and fitted analogs*. *Inherent-analog* devices work on the principle that many simple mechanisms may be described mathematically. *Fitted analogs* are not concerned with the individual terms and manipulations of a mathematical expression, but rather are concerned with the curve or surface which results after the mathematical expression has been solved and plotted. In a sense, the fitted analog is merely a storage device to remember the solution to a particular mathematical relation, whereas inherent-analog devices solve the mathematical relation each time a new set of variables is inserted into the mechanism.

Fitted analogs are, in general, more closely associated with problems in statics, whereas inherent analogs find their greatest application in the field of dynamics (or equations in which time is involved).

The technique of perturbation-equation analogs, which is discussed in this article, is an inherent analog which can meet the requirements of the chemical process industry. (Perturbations are disturbances imposed on a system at rest or in periodic motion.) In this field, it is required that a pressure be maintained at one specified value, that a temperature be maintained at another value, etc. *Control is applied to maintain these operating points; perturbations about these points determine the control required.*

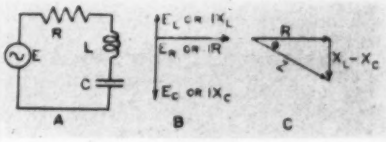


Fig. 1. Series circuit with R, C, and L. Phase of voltage across each element is shown in center; impedance triangle is shown at right (see Appendix A).

Mathematical Concepts

No new mathematical concepts need be learned to understand the operation of analog computers. Appendices A, B, C, and D present the simple proofs for a few well-known mathematical concepts that will assist in understanding computer principles. (Appendix A shows that the reactance of a capacitor can be expressed as $-j/\omega C$; and that the reactance of an inductor is $j\omega L$. Appendix B describes the Fourier concept briefly. Appendix C shows that a sine wave (or Fourier component) can be differentiated by multiplying it by $j\omega$; Appendix D shows that the sine wave can be integrated by multiplying it by $1/j\omega$.)

The symbol "p" is used in integro-differential equations to represent the differential operation, and "1/p" to represent the integration operation. That is, di/dt can be represented by pi; and $\int i dt$ can be represented by i/p, where i is the current in the circuit. These few concepts will assist the analog-computer user to understand computer principles, but are not essential to learning the technique for computer set up or operation.

Perturbation-equation Analogs

Response curves can be used to simulate a process or device. Plots of the various variables show the effect of each variable on the process or device. Slopes drawn at appropriate points on these curves give the coefficients needed to present the process or device in mathematical-equation form. These equations then can be set up in the computer and solved rapidly. A typical example will be presented for an airplane problem; the same technique could be applied to process-control problems.

Electronic Integration

One basic technique for use of analog computers is to express the process under analysis by integro-differential equations (equations which contain both differential and integral terms). A typical integro-differential equation is the equation for the current in a series circuit containing resistance, capacitance, and inductance (Fig. 1). This equation is:

$$iR + L\,di/dt + (1/C)\int i dt = E = f(T)$$

Equations like this can be solved either by electronic integrators or dif-

*In the article "Solving Process Control Problems by Analog Computer," (see *Instruments and Automation*, October, 1954, pages 1624-1626), analogs are classified as (1) mathematical, (2) direct electrical, and (3) abstract. The mathematical analog is the mathematical expression for the device or process being simulated; the direct electrical analog is the electric-circuit equivalent of the device or process being simulated; the abstract analog is a "black box" that has the same response as the device or process being simulated. Thus, the "inherent" analog of this article includes the mathematical and direct-electrical analog; and the "fitted" analog is essentially the same as the "abstract" analog of the previous article—EDITOR.

ferentiators. Electronic integrators are used as the basic building blocks of analog computers because differentiators have larger outputs for high-frequency signals, whereas integrators have smaller outputs for high-frequency signals. Hence differentiators emphasize noise impulses excessively and have more high-frequency oscillation problems than do integrators. Integrators are basic circuits in analog computers.

Electronic integrators used in analog computers are based on the charging of a capacitor (Fig. 2). This action is similar to a liquid flowing into a tank: the volume of the liquid in the tank is equal to the integral with respect to time of the liquid flow. There is one difference between electron flow in a simple RC circuit (Fig. 2) and fluid flow in a pipe-tank circuit; the electron flow is reduced by the back voltage built up across the capacitor. This back voltage produces an exponential (rather than linear) rise in voltage and hence limits the usefulness of the RC circuit as an integrator.

Fundamentally, the RC circuit possesses the properties needed in an integrator—(1) the resistor converts the applied voltage into an equivalent current (the constant of proportionality is the ohmage of the resistor), and (2) the capacitor has the property to sum this current (the constant of proportionality is the capacitance of the capacitor). It is theoretically possible to make use of these two properties of resistors and capacitors to produce a perfect integrator. The expedient used is to introduce a voltage source (which has the property of developing a voltage whose magnitude is equal to and whose polarity is opposite to that of the capacitor voltage) in series with the RC network (Fig. 3). This eliminates the effect of back voltage on the resistor and, consequently, the current through the resistor is always proportional to the input voltage ($E_i = iR$). This expedient makes a perfect RC integrator: the voltage across the capacitor equals the integral of the resistor current:

$$E_c = (1/C) \int i dt$$

As i equals E_i/R, this equation becomes:

$$E_c = (1/RC) \int E_i dt$$

This combination then produces a system wherein the voltage across the capacitor is proportional to the integral of the input voltage. This equation also demonstrates the effect of the resistor and capacitor in the integrator circuit.

A simplification can be obtained by noting that the voltage across the compensating source (E_o) is equal and opposite to the voltage across the capacitor:

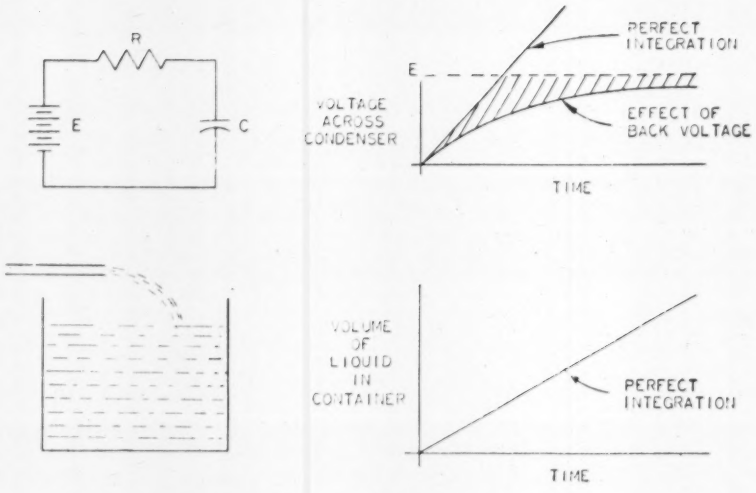


Fig. 2. Comparison of electron flow in an RC circuit and fluid flow in a pipe-tank circuit.

$$E_o = -E_c$$

Substituting this is in the integration equation:

$$E_o = -(1/RC) \int E_i dt$$

This equation shows that for the circuit of Fig. 3, the output voltage is proportional to the integral of the input voltage, and the constant of proportionality is $-1/RC$.

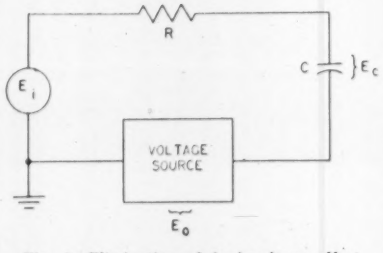


Fig. 3. Elimination of back-voltage effect.

Practical Integration Circuits

The ideas expressed have limitations when a practical circuit is introduced to implement the compensating voltage source. In practice, a high-gain amplifier (see references 1, 2, and 3) is used, as shown in Fig. 4.

The input to this amplifier is the voltage difference between ground and a point called the *virtual ground* (the junction of the resistor and the capacitor). Thus, an input to the amplifier occurs whenever the voltage across the resistor is not equal to the input voltage, or (to state the same thing differently) whenever a back voltage exists.

The fact that the input must be a finite amount to produce compensating voltage at the output of the amplifier precludes perfect integration. However, integration can be made as nearly perfect as is desired by increasing amplifier gain. The effect of using an amplifier whose gain is less than infinite can be evaluated by writing the equations for the circuit of Fig. 4. This analysis shows that the attenuation is the same as in an RC circuit, but the integrating time is equal to gRC—that is, it is g times as long as the conventional RC circuit of Fig. 5. (The term "g" stands for the gain of the amplifier.)

Integrator Gain

An important aspect of the electronic integrator when applied to the solution of practical problems is its so-called *gain*. A perfect integrator performs the mathematical operation:

$$E_o = (1/K) \int E_i dt$$

The purpose of including 1/K can be shown as follows: This equation must equate, not only numerically but also dimensionally. As input E_i is volts, output E_o is volts, and dt is seconds. This gives

$$\text{volts} = (1/K)(\text{volts})(\text{seconds})$$

Therefore, to equate dimensionally, K must be in seconds.

As has been shown in the equation for the basic integrator—

$$E_o = (-1/RC) \int E_i dt$$

the coefficient of the integral term is the constant of proportionality (or the gain) of the integrator. In general,

$$\text{integrator gain} = 1/K$$

As K is in seconds, K is often termed the "time constant" of the integrator. This is somewhat of a misnomer which has arisen from its close association with the step function.

A constant voltage, or step function, applied to the input of an integrator causes the output voltage to increase

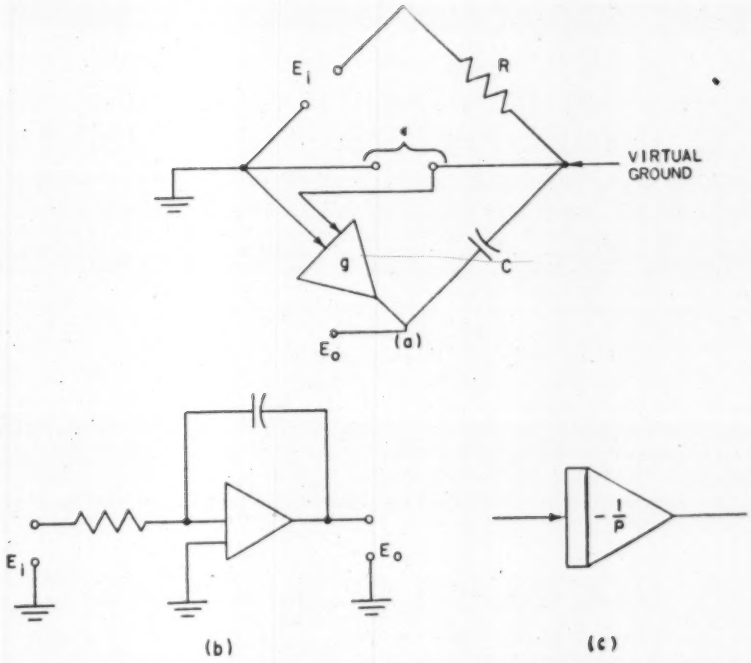


Fig. 4. Implementing elimination of back-voltage effect by use of high-gain amplifier.

at a constant rate (volts per second). The output divided by the input is then:

$$\frac{\text{output}}{\text{input}} = \frac{\text{volts/sec.}}{\text{volts}} = \frac{1}{\text{sec.}} = \frac{1}{T}.$$

However, the output divided by the input is the gain. A comparison of the two preceding equations shows that K and T are numerically equal although derived from different considerations; thus the misnomer "time constant."

Electronic Summation or Subtraction

It is necessary to add or subtract voltages in analog solution of equations. Accurate addition or subtraction can be performed by *summing amplifiers*, which permit *parallel addition or subtraction* wherein each voltage can be referenced to ground. This is in contrast to *series addition* or subtraction, wherein all but one voltage must be able to "float" (be referenced atop the grounded signal).

Summing amplifiers are similar to integrating amplifiers in that their principle of operation is to produce a current proportional to the input voltage (Fig. 6). However, this current, instead of being integrated in a capacitor, is fed into another resistor. The several inputs also feed current into this resistor and, consequently, the voltage across this resistor is then proportional to the sum of the currents multiplied by the resistance ohmage.

The gain of a summing amplifier can be determined from an analysis similar to that of the integrator. It can be shown that the gain equals the ratio of R_{SIGMA} to R_R.

This concludes the discussion of integrators and summing amplifiers, and leads to the application of these devices.

Application of Electronic Analog Computers

In general, analog computers are applicable to any physical system which can be described by a system of linear integro-differential equations. By using the technique of perturbation (linearization), these computers may be applied to nonlinear systems (see reference 4).

Integro-differential equations may be written for a host of systems. Integrals (integro-terms) occur, for example, whenever lag exists in a system, in heating up or cooling of a system, when there is flow into or out of a container, when inertia or damping effects are present, whenever a pressure change occurs, whenever an exothermic or endothermic reaction takes place, and many others. Differential terms occur whenever there exists a rate of change of some variable, such as a rate of change of pressure, volume, temperature, chemical reaction time, and so forth.

Analog computers can simulate systems and processes during the design stages to determine the proper control to be applied. For example, in the chemical process field the starting up and shutting down of large plants is often a critical operation. By applying the perturbation technique to several intermediate modes of operation between a shut-down and an operating plant, it is possible to determine how to vary the control parameters in starting up and shutting down to avoid system instabilities which could possibly build certain variables up to the point where physical damage to the plant could occur.

Another place where the analog computer can shed much light in the chemical process industry is in the field of long-period instabilities. It is difficult for the human intelligence to recognize small periodic fluctuations in a variable where the period of the oscillation is longer than thirty to forty seconds. Often, variations of this period are passed over as random disturbances caused by changing ambient conditions, whereas they are actual low-frequency instabilities which can be corrected by proper control and which can be recognized easily on an analog computer by changing the time scale. Changing of the time scale speeds up the apparent rate at which the plant is operating.

Perturbation Technique

The technique of perturbation, or linearization, consists first in establishing a set of equations which describe the static conditions of the device or process (airplane or plant). These static equations differ from the dynamic equations in that all functions of time are omitted; thus, terms such

Fig. 5. Conventional RC circuit.

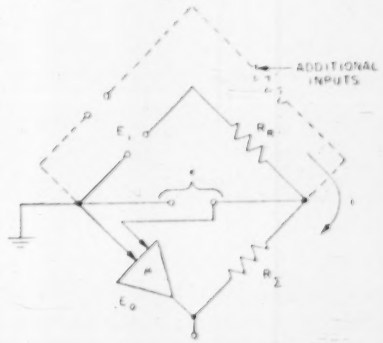


Fig. 6. Summing amplifier.

as damping and inertia are not included. From these static equations, steady-state values are determined; perturbation or linearization then takes place about these steady-state values. Dynamic equations (equations involving time) then are written to describe disturbances about the steady-state values; it is these dynamic equations which determine the control required.

In the airplane of Fig. 7, this consists in summing the forces along the lift and drag axes, and the moments about the wing axis—that is, pitching moments. These equations are (Fig. 7):

$$\begin{aligned} W \sin \gamma_0 + D_0 &= T_0 \cos \sigma_0 \\ W \cos \gamma_0 - L_0 &= T_0 \sin \sigma_0 \\ M_0 &= 0 \end{aligned}$$

In these three equations, there are five unknowns γ_0, σ_0, D_0, L_0 and M_0 and two knowns, W and T. The knowns are inputs; the unknowns are outputs, the conditions under which the airplane must fly to sustain itself. In a process plant, this analogy probably would be reversed, with the knowns being the desired outputs, and the unknowns the inputs which must be maintained to produce the desired output.

To obtain the five unknowns requires not only the three static equations but also two additional relations to satisfy the algebraic requirement for simultaneous equations—namely, that the number of equations must equal the number of unknowns. Drag and lift both vary with σ, angle of attack. The relation between drag and angle of attack, and the relation between lift and angle of attack are the two relations needed.

In general, the two relations are nonlinear and are most easily handled in graphical form. The data for the two relations are obtained either from estimates of the curves or from wind-tunnel data, depending on the stage of the design. The important thing here is that the two relations are nonlinear.

For a specific weight and thrust, a value for each of the five unknowns can be obtained from the five simultaneous relations using combined algebraic and graphical techniques for solution. Each of the unknowns has a zero subscript; this indicates that these are the steady-state values about which we linearize to obtain the dynamic equations. Thus the slope at the D_0 and L_0 points of the nonlinear relations involving drag, lift, and angle of attack provides the constants for the dynamic equations which follow. The weight and thrust terms in the dynamic equations are obtained simply by mathematically differentiating the weight and thrust terms in the static equations to obtain their slope. Inertia terms are added because variations with time are being considered.

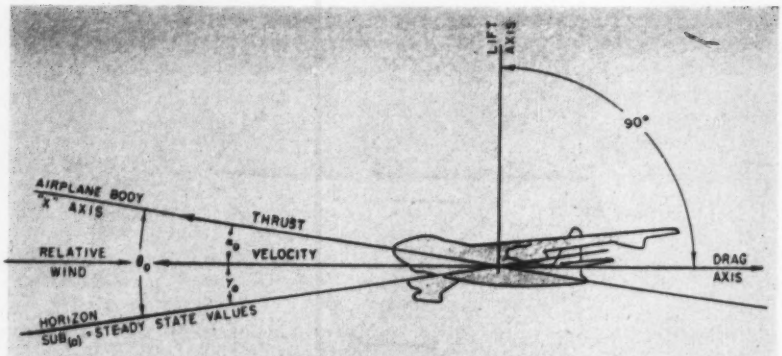


Fig. 7. Longitudinal motion, steady state.

In deriving the following dynamic equations liberal use has been made of the substitution sin x is approximately equal to x for small angles.

Airplane Analysis

In the following, an electronic analog computer is applied to the solution of linearized perturbation equations involving the forces acting on an airplane. This choice is justified primarily by the fact that the mechanics of forces and moments are fundamental to all branches of science. In deriving these equations, liberal use is made of the substitution sin x $\simeq$ x for small angles.

In these equations, "sub zero" stands for the steady-state value of the variable, or the operating point about which a perturbation takes place. Then the slope (linearization) of the curve relating force to the variable at this point is the coefficient. For example, the slope of the curve of lift vs. angle of attack (σ) is the coefficient in:

Change in lift due to change in angle of attack
Slope of lift vs angle of attack at σ_0 point
Change in σ due to perturbation

$$\Delta L = \left(\frac{\partial L}{\partial \sigma}\right)_0 \Delta\sigma$$

In the following equations, each term is representative of a force or moment which acts along or around the appropriate axis (Fig. 7).

Forces along lift axis:

Centrifugal Force
Weight Component
Engine Thrust Component
Slope, Lift vs Angle of Attack
Slope, Lift vs Velocity

$$\left(\frac{W}{g} V_0 p - W \sin \gamma_0\right)\gamma + \left(T \cos \sigma_0 + \frac{\partial L}{\partial \sigma}\right)\sigma + \left(\frac{\partial L}{\partial V}\right)V = 0$$

Forces along drag axis:

Weight Component
Engine Thrust Component
Slope, Drag vs Angle of Attack
Force = Mass X Acceleration
Slope, Drag vs Velocity

$$\left(W \cos \gamma_0\right)\gamma + \left(T \sin \sigma_0 + \frac{\partial D}{\partial \sigma}\right)\sigma + \left(\frac{W}{g} p + \frac{\partial D}{\partial V}\right)V = 0$$

Moments about pitch axis:

Moments about pitch axis:
Inertia
Rotary Damping
Slope, Pitching Moment vs Angle of Attack
Slope, Pitching Moment vs Velocity

$$\left(I_y p^2 + \frac{\partial M}{\partial q} p\right)\theta + \left(\frac{\partial M}{\partial \sigma}\right) + \left(\frac{\partial M}{\partial V}\right)V = 0$$

Substituting numerical values for the coefficients of these equations, we obtain the following equations:

$$(194{,}000\ p)\gamma + (-469{,}000)\alpha + (-23.5)V = 0$$

$$(-8{,}600)\gamma + (-2{,}000)\alpha + (-267\ p - 3.8)V = 0$$

$$(-9{,}770\ p^2 - 26{,}000\ p)\theta + (-200{,}000)\alpha + (-158)V = 0$$

Rewriting these equations, moving the highest order term in each equation to the right hand side and noting that $\gamma + \alpha = \theta$, and therefore, $p^2\theta = p^2(\gamma + \alpha) = p^2\gamma + p^2\alpha$, because differentiation is a linear process:

$$+ (-469{,}000)\alpha + (-23.5)V = -194{,}000\ p\gamma$$

$$(-8{,}600)\gamma + (-2{,}000)\alpha + (-3.8)V = 267\ p\ V$$

$$(-26{,}000\ p)\theta + (-200{,}000)\alpha + (-158)V = 9{,}770\ p^2\theta$$

These are the equations to be simulated in the analog computer.

Setting Up the Computer

These equations involve the three independent variables θ, γ, and V. The highest order of θ is the second, and the highest order of γ and V is the first. The lowest order of all three is the zero order. Thus for simulation purposes, γ must be integrated once, θ twice, and V once (Fig. 8). Since, in analog integrators, g is much greater than 1, and RC is chosen equal to unity, the integrator gain ($1/K$ or $-1/RC$) is minus unity, and the equation for the integrator becomes $(-1/RCp) = (-1/p)$.

The four electronic integrators in Fig. 8 thus provide all the differential or integral combinations of the independent variables in the equations to be solved—except α. However, α may be obtained through use of the relation $\alpha = \theta - \gamma$, as shown in Fig. 9.

We now have a voltage representative of all the independent variables in the equations to be simulated. The next step is to obtain a voltage proportional to each term of the equations. For example, take the α (angle of attack) term in the second equation. This term says that for every radian of change of angle of attack, the drag changes 2000 pounds. From a mathematical point of view, the coefficient is multiplied by the variable.

Up to this point we have introduced no means of multiplying with analog computers. To prevent discontinuity in presentation, assume that it is possible to multiply by the device represented by the symbol in Fig. 10.

Since each of the equations to be simulated is a summation of terms, it will take three summing amplifiers (one for each equation) to obtain an analog of these equations. Further, each voltage input to these three summing amplifiers must represent a term of the equations—that is, a variable multiplied by the proper coefficient. This is shown in Fig. 11. The summing amplifiers are marked "lift," "drag," and "pitch."

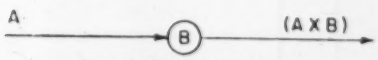


Fig. 10. Multiplying device.

The output of the summing amplifiers is a voltage proportional to the sum of the terms on the left-hand side of the basic equations. *If these voltages are proportional to the left-hand side, these same voltages must be proportional to the right-hand side of the equations because "quantities equal to the same quantity are equal to each other."* By connecting the output of the summing amplifiers to the input of the highest-order integrators, the necessary and sufficient conditions for the solution of the equations are satisfied—namely, that the right-hand side be equal to the left-hand side. This connection has been made in Fig. 11. This completes the simulation of the airplane equations of motion.

Voltages, representative of disturbing forces or motions, may be entered at the appropriate place in the simulator. The corresponding response at any point may be read out as a voltage.

Multiplication

In most analog computers, multiplication by a constant coefficient is per-

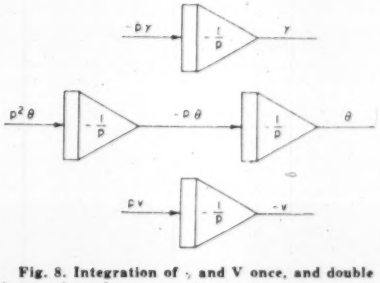


Fig. 8. Integration of γ and V once, and double integration of α.

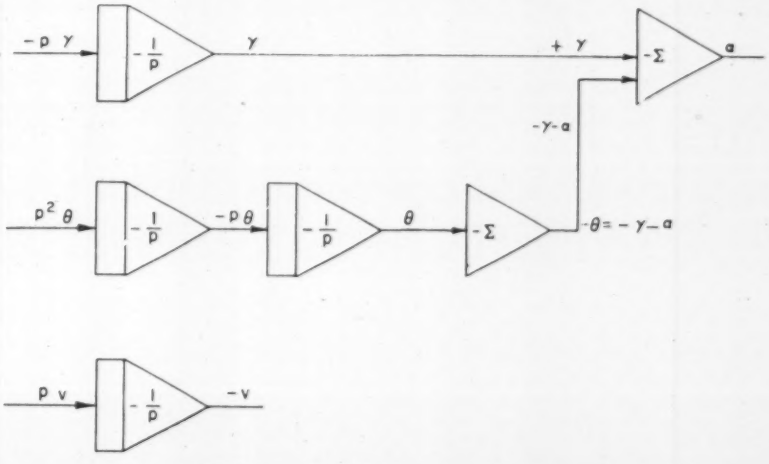


Fig. 9. Obtaining α by subtracting α from γ.

formed by use of a potentiometer or resistance divider (Fig. 12). The disadvantage with this method is that the potentiometer or divider can only multiply by less than unity, whereas all the coefficients in the airplane problem are much greater than unity. Therefore, the coefficients are reduced to values less than unity by dividing through each equation by a value sufficiently large to reduce its coefficients to values less than unity. However, this requires proof that the motions of the airplane are not falsely reproduced by this change in the equations.

It can be shown by analyzing the determinant of the airplane equations

$$\begin{vmatrix} L_\gamma, & L_\alpha, & L_V \\ D_\gamma, & D_\alpha, & D_V \\ P_\gamma, & P_\alpha, & P_V \end{vmatrix}$$

that division of each element in a row or column leaves the roots of the determinant unchanged.

$$\begin{vmatrix} \frac{L_\gamma}{K_1}, & \frac{L_2}{K_1}, & \frac{L_V}{K_1} \\ \frac{D_\gamma}{K_2}, & \frac{D_\alpha}{K_2}, & \frac{D_V}{K_2} \\ \frac{P_\gamma}{K_3}, & \frac{P_\alpha}{K_3}, & \frac{P_V}{K_3} \end{vmatrix}$$

Dividing both rows and columns by suitable factors often permits more accurate use of the computer from a signal-to-noise-ratio viewpoint.

Dividing the lift, drag, and pitch equations by 194,000, 2670, and 9770 respectively, the actual equations used in the simulation are obtained:

$$+(-2.42)\alpha + (-0.00012)V = -p\gamma$$

$$(-3.22)\gamma + (-0.75)\alpha + (-0.0014)V = 0.1\,pV$$

$$(-2.66)p\theta + (-20.5)\alpha + (-0.016)V = p^2\theta$$

Those coefficients greater than unity are obtained through use of summing amplifiers with gains of ten, rather than unity-gain amplifiers, and/or by using a multiplicity of inputs. This is done for signal-to-noise-ratio considerations. The final simulation diagram is shown in Fig. 13.

In conclusion, perturbation-equation analog devices are not at present used as such in the control of chemical process plants. However, this article may contribute to their use in the future.

Appendix A—Reactance of Capacitors and Inductors

An inherent (direct electrical) analog simulates the system by use of resistors, inductors, and capacitors. The currents and voltages in the electrical system then are proportional to the variable being examined—temperature, pressure, etc. These currents and voltages depend on the resistance and reactance of the electric-circuit components.

The resistance of a resistor is R; it is independent of frequency (within limits); it poses no phase problems because the current through and the voltage across the resistor are in phase. Hence the simple term "R" defines the resistance of a resistor.

The reactance of capacitors and inductors is not defined as simply. Both are frequency sensitive, as shown by the familiar equations for the reactance of a capacitor (X_C) or an inductor (X_L):

$$X_C = 1/(2\pi fC) = 1/\omega C$$
$$X_L = 2\pi fL = \omega L$$

These equations are not sufficient for use of the reactance terms in equations because the reactances are not in phase with the resistance in the circuit; hence resistances and reactances can not be added together directly. The term "j," used to express a 90-degree phase change of any vector term, is used to make it possible to add resistances and reactances.

The symbol j means $\sqrt{-1}$, and represents a 90-degree rotation of a vector, or a phase change of 90 degrees. Hence, a complete and useful expression for the reactance of a capacitor is $-j/\omega C$. This says that the reactance is $1/\omega C$ and the phase is -90 degrees.

Similarly, the reactance of an inductor is $X_L = j\omega L$.

The total impedance of a series circuit containing resistance, inductance,

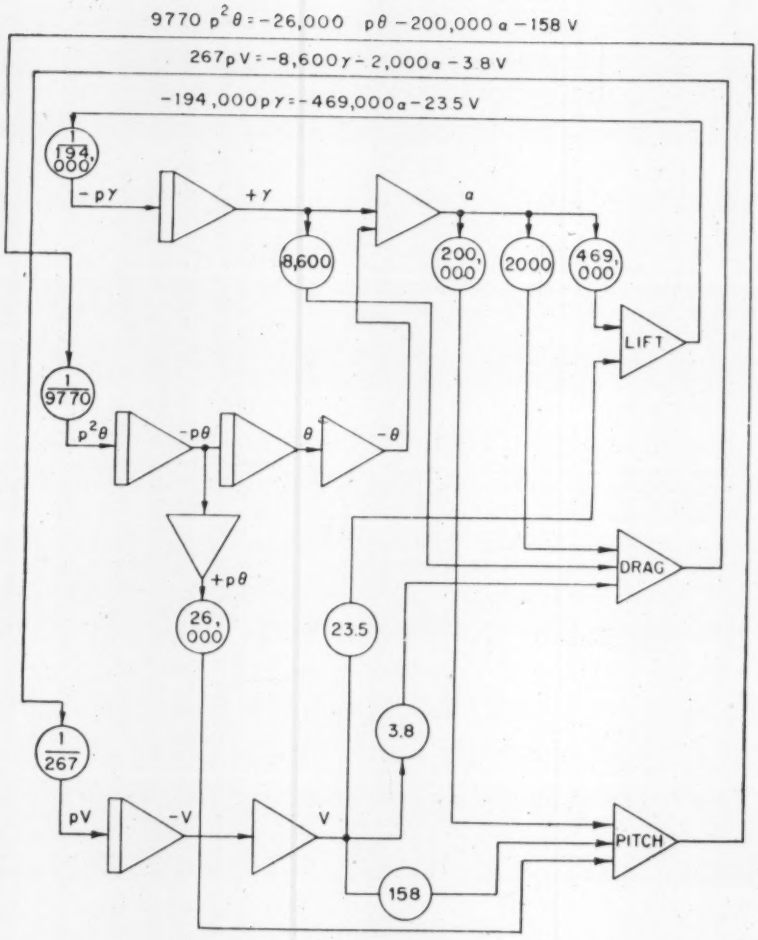


Fig. 11. Computer setup using hypothetical multiplying devices (shown as circles with numbers).

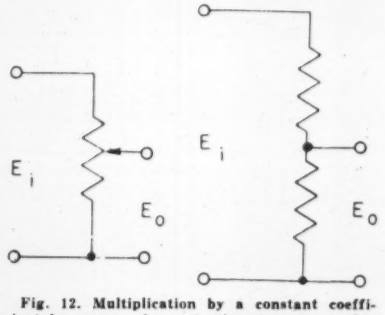


Fig. 12. Multiplication by a constant coefficient by means of a potentiometer or a resistance divider.

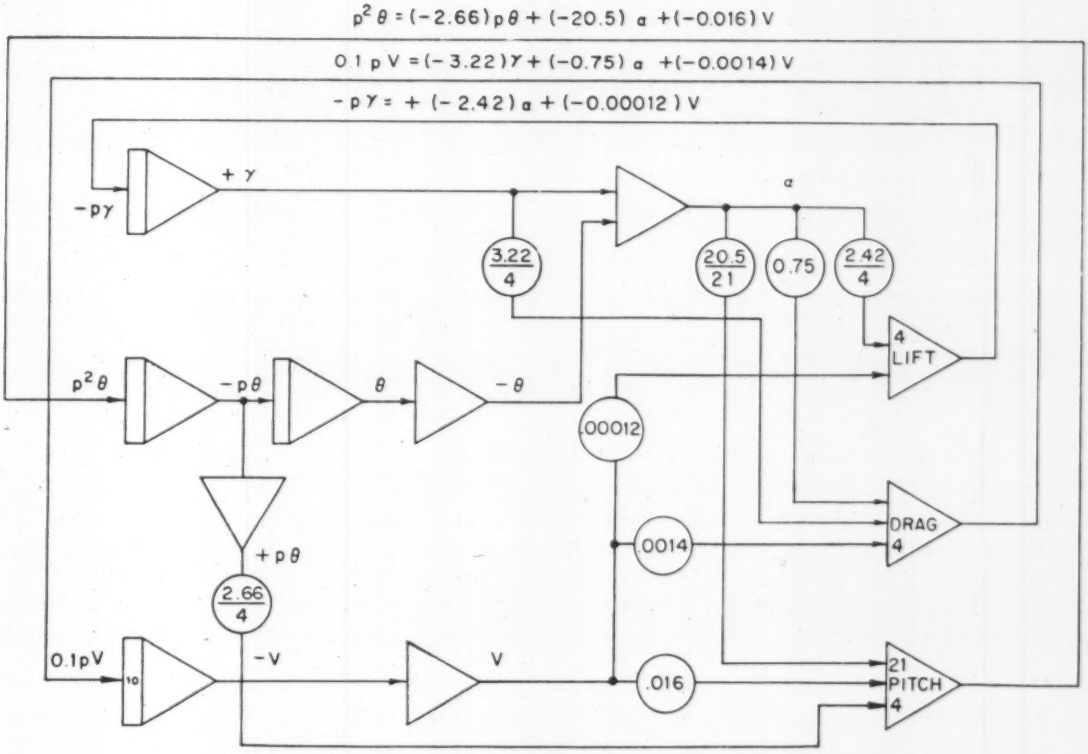


Fig. 13. Final computer setup for solving airplane equations of motion.

and capacitance (Fig. 1) can be expressed:

$$Z = R + jwL - jwC$$
$$= R + j(wL - 1/wC)$$

Appendix B—Fourier Analysis

Jean Baptiste Fourier first established that any complex wave shape can be decomposed into (or synthesized by) a series of sine and cosine terms, called Fourier components. This says simply that any wave shape consists of a series of sine waves of various amplitudes and phases.

It is a property of these sine and cosine terms that they act independently in a linear system. Therefore, it is possible to decompose a complex wave into its Fourier components, integrate or differentiate each component separately, and then recombine the integrated or differentiated components to form the integral or derivative of the original complex wave. This process is not physically accomplished in analog devices, but the Fourier analysis permits simplification in the mathematical analysis.

Appendix C—Differentiation

A Fourier component, sinwt, can be differentiated by multiplying it by jw. This can be shown as follows:

$$(d/dt)\ (\sin wt) = w \cos wt,$$

but

$$\cos wt = j \sin wt.$$

Therefore,

$$(d/dt)\ (\sin wt) = jw \sin wt.$$

Dividing by sin wt

$$d/dt = jw,$$

under the condition by which this was proved—that is, differentiation of a sine component. It can be proved likewise that the derivative of a cosine component can be obtained by multiplying the component by jw.

Appendix D—Integration

A Fourier component, sin wt, can be integrated by multiplying it by $1/jw$. This can be shown as follows:

$$\int \sin wt\, dt = (-1/w) \cos wt$$

but

$$\cos wt = j \sin wt.$$

Therefore,

$$\int \sin wt\, dt = (-1/w)\ j \sin wt$$

Dividing through by sin wt,

$$\int = -j/w$$

Multiplying the right hand side by j/j, or unity:

$$\int = -1/jw.$$

As in differentiation, integration is equivalent to multiplying by $1/jw$ only when applied to sine or cosine functions.

To summarize, we have shown that, for sine and cosine waves, differentiation is equivalent to multiplying by jw, and integration is equivalent to multiplying by $1/jw$. Then, since jw always appears in exactly this combination, notation can be simplified by letting

$$jw = p.$$

To differentiate, we multiply by p, and to integrate we multiply by 1/p. We can extend this simple multiplying procedure to a complex wave if we realize, as stated previously, that a complex wave is merely a linear combination of a group of sine and cosine terms. Consequently, it is seen that both integration and differentiation, with respect to time, are processes which are linear—that is, after integration or differentiation has been performed on a complex wave, the components still combine as in arithmetic, or linear, addition.

References

1. Williams, A. J., Jr.; Tarpley, R. E.; and Clark, W. R.; "D-C Amplifier Stabilized for Zero Gain," *A.I.E.E. Transactions*, Vol. 67, 1948, pages 47-57.

2. Goldberg, E. A.; "Stabilization of Wide Band D-C Amplifiers for Zero and Gain," *R.C.A. Review*, June, 1950, Vol. XI, No. 2.

3. McCoy, R. D., and Bradley, F. R.; "Isolation Circuits for Analog Computers," *Electronics*, October, 1952, Vol. 25, No. 10.

4. Liapounoff, A., "Probleme General de la Stabilite du Mouvement," *Annals of Mathematics Studies No. 17*, Princeton Press, 1947.

5. Bocher, M., *Introduction to Higher Algebra*, Macmillan Company, New York, 1907.

The Automatic Factory—

A Critical Examination

Complete automation of factories is retarded, not by any attitude on the part of manufacturers, but by four more-practical obstacles—(1) complexity of production processes, including control of inter-related variables, (2) lack of qualified personnel to design manufacturing processes with integrated automatic handling plus automatic control, (3) lack of cooperation between manufacturers of handling, controlling, and production equipments, and (4) high costs associated with the development of completely automatic factory-production processes.

STEPHEN A. JUNE
JOHN D. BARDIS
LEE H. LURIO
LEONARD S. POLANER
OYSTEIN SAGEDAHL
HERBERT A. SKLENAR
BERNARD K. YENKIN

Part IV

Obstacles to the Automatic Factory

WHAT factors determine the degree and the rate at which progress toward the automatic factory will be experienced by American manufacturers? Implicit in this question is still another—what *obstacles* lie in the way of the evolution of the automatic factory?

Basic Attitudes

Today it is almost the exception to find a discussion on the automatic factory which does not make as one of its chief points the proposition that a major obstacle to progress is the absence of a certain "attitude" on the part of industrialists and businessmen generally. Proponents of this proposition invariably indicate that much additional progress toward automatic factories awaits only the removal of present attitudes, this removal to be accomplished by a *rethinking process*. The implication is that through rethinking the functions performed in any given factory, progress toward automaticity is assured. This viewpoint is not entirely justifiable.

Many people regard the automatic factory as here now—or at least as being not many years away. Much of this groundless optimism is no doubt traceable to misunderstanding and to unsophisticated imagination. But some of the blame must also lie with those who present lack of rethinking as the fundamental obstacle.

The error is not that this analysis is inaccurate, but rather that it is incomplete.

Whether justifiable or not, the implication that the automatic factory lies in the near future is often drawn from current writings. It is important, however, to note that many manufacturers react in an opposite and negative manner. They read these claims and then they look at the present state of industrial mechanization, particularly their own. In their eyes the disparity is apt to seem great—as indeed it is.

One manufacturer has reacted in the following manner: "The writing of some of these editors seems to go to extremes on the theoretical side—such as the thought of push-button operation of a factory with various operations being performed by mechanical men controlled by computing machines, punched tapes, or similarly controlled mechanisms."

What is needed is clarification because there is a danger that the real possibilities for technological development will be ignored simply because of this negative reaction. Therefore, a more realistic definition of the obstacles confronting progress toward the fully automatic factory must be made. A change in attitude alone will not clear the path; the obstacles are real ones—they cannot be "rethought" away.

Specific Obstacles

The deterrents to progress toward the automatic factory can be broken into four classifications:

1. Complexity of production processes.
2. Lack of qualified personnel.
3. Decentralization of essential skills.
4. High cost of development.

These obstacles exist in varying degree.

Complexity of Production Processes

The degree of complexity of a factory process depends on the number of variables which must be measured and corrected.

In a thermostatically-controlled furnace there is but one variable—temperature. This variable can be measured by a simple bimetallic strip which controls an electric contact; thus, temperature is automatically controlled.

However, to manufacture a product in a factory, not just one variable but a multiplicity of variables must be controlled simultaneously. For example, let us examine a paper mill. Suppose a paper manufacturer desires to control automatically his production of paper so that precisely ¼ of an inch could be trimmed from the continuous sheet of paper coming off the rolls. To accomplish this it would be necessary to isolate each of the variables affect-

Prepared for General Georges F. Doriot in partial fulfillment of the requirements of the manufacturing course at the Harvard Graduate School of Business Administration.

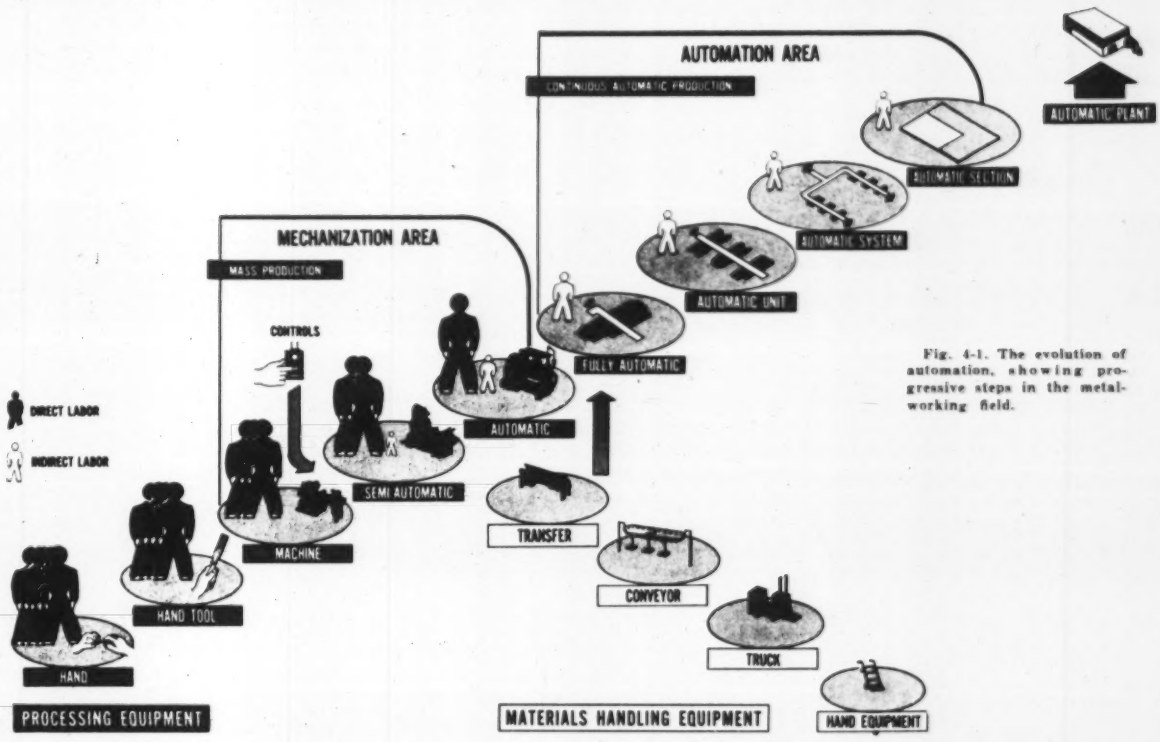


Fig. 4-1. The evolution of automation, showing progressive steps in the metal-working field.

ing the edge on the finished paper—tension, water content, temperature, and many others: it has been estimated that more than *ninety variables* affect the edge.

Once these variables have been isolated, the really difficult job begins: determining *mathematically* (or quantitatively) the *effect* of each variable on the paper's edge. If the computer is to replace the human control-operator, mathematical relationships are necessary. They must be preset into the "memory" of the servomechanism. The servomechanism cannot adjust for any factors not preset into its memory—it can do only what it has been told to do.

The difficulty of determining these mathematical relationships can be demonstrated by another example. A petroleum company wanted to automatically control the rate of flow during a small part of a refining process. The variables affecting this rate were few. Yet, four men worked almost four years to determine quantitatively the relationships between the variables and the rate of flow—and this was only a small part of the entire process.

The two examples mentioned illustrate the complexity of processes as applied to installing control mechanisms.

Lack of Qualified Personnel

A second major obstacle to progress toward an automatic factory is the shortage of personnel trained in systems engineering. As has been stated, the automatic factory must be an integrated unit—with automatic production lines controlled automatically. If a manufacturer is to progress toward the automatic factory, an important requirement is that he have men available who are trained in this integrated approach toward automatization. These men are known as systems engineers.

The engineers presently working in industry are lacking on two counts. First, they have not apprised themselves of many of the new developments and techniques which have come about in the past few years. Secondly, they are specialists in one type of engineering. As a result, each element in a process is attacked separately—with little regard to how the whole process can be made more automatic.

The reason for the shortage of systems engineers lies in the amount of training which a man must undergo before he becomes fully qualified. The training period is considerably longer than that for a conventional specialized engineer. The present supply of systems engineers consists primarily of faculty members at large engineering schools, such as at M.I.T. These men are already occupied with their teaching work, but do manage to give some time to outside consulting work in automatizing processes. The total amount of time which they are able to give is infinitesimally small when compared to the job to be done. As a result, should a manufacturer decide that his factory is susceptible to automatization, it is difficult for him to find anyone capable of carrying out such a program.

However, many plants partially automatize without systems engineers, depending on the complexity of a particular process and the degree of automaticity desired.

Decentralization of Essential Skills

The significant components of an automatic factory are production tools, material handling equipment, and testing equipment or quality control apparatus, each tailored to all the others to give an integrated production process.

In order to accomplish this integration, a great number of specialized skills must be brought to bear on the problem. The systems engineer must have the broad picture of the total process, but he must be able to call on a wide variety of individual equipment-manufacturing talent if the factory is ever to be made automatic. This is the third obstacle.

The different skills are highly decentralized. Some of them are found in the machine-tool industry, others in the control-instrument industry. The manufacturer, though interested in making his processes more automatic, often finds it impossible to assemble the various specialized skills which bear on the problem.

Each industry producing equipment related to this problem is interested primarily in the ways of improving its own product. There is little interest in improving the function of this product in relation with the other elements in the factory in which it is to be installed.

This problem of non-cooperation among the producers of the elements of the factory is exemplified by the following illustration. A machine-tool executive makes this statement:

> "So far as I know, (there is) no really good cooperation between people who manufacture handling devices and the people who manufacture machine tools. These are two different kinds of cats, and most generally, I think, the machine tool builder would attempt to devise his own handling device."

Moreover, machine-tool builders have in the past been concerned with their short-run profit prospects. They lack both the incentive and the knowledge for incorporating materials handling and controls into their products. One machine-tool manufacturer made the following statement regarding the incorporation of materials-handling and control equipment into his products to produce "automation."

> "We will use it wherever we can sell it, but in general it will be in the form of attachments to relatively standard equipment, and we will be very cautious in its application. In short, our policy will be rather to follow the demand than to force it. In certain instances of course, where we ourselves are convinced of its value, we will force the point; but as for a major development program (in this field) is concerned, I do not believe that we, nor many companies like ourselves, are ready to go that far."

Thus, we see that in the above example the machine-tool builder (1) finds it difficult to cooperate with the materials-handling-equipment manufacturer and (2) is not able to incorporate many materials-handling techniques into his own products. As a result, progress toward automatic processes is retarded.

High Cost of Development

The fourth major obstacle to progress toward the automatic factory is the high investment required in development work before any tangible results can be obtained.

A clear example of the amplitude of development cost occurs in the case of "Project Tinkertoy," a government-sponsored project to develop a method for producing electrical circuits automatically. (This development will be discussed in detail in a later chapter.) In this project, an investment of $4,700,000 was necessary just to develop a pilot plant. And even in this plant complete automaticity has not been achieved, the automatic operations taking place primarily with regard to assembly.

Evolutionary Solution

Can the formidable obstacles, outlined in four areas, be overcome? The answer is not obvious or easy, but an approach may be made by looking at the experience of American companies with problems of automatic operations. However, no company has had experience with an entirely automatic factory. Instead, the progress that has been made confines itself largely to specific functions such as machining, materials handling, assembling, inspection, etc.

A position which this report endorses is that "this job of automatizing the elements" will continue to be solved as it has in the past—on a step-by-step evolutionary basis.

The evolutionary growth of automaticity is shown in Fig. 4-1, which shows the growth of automaticity in the metalworking industries as seen by the Manufacturing Services Division of the General Electric Company. Its chief value is its dramatization of the evolution theme.

But a question remains: how, if at all, may the rate of growth be increased? An answer to this requires answers to the questions asked concerning the obstacles to the automatic factory. A review of the problems companies have encountered while attempting to automatize the elements of the factory should be of value in answering these questions. This will be done in succeeding discussions.

Watthour-meter Testing

WASHINGTON, D.C.—A more rapid method for precisely measuring the rate of alternating-current watthour meters has been developed by T. L. Zapf and A. W. Spinks of the National Bureau of Standards. This method reduces to a minimum the use of an electrodynamic wattmeter and the laborious process of holding the a-c. power constant while the meter registration is accumulating. In high-precision NBS tests this has, in the past, been done by observing the number of disk revolutions occurring in a fixed time interval during which the power has been held constant.

Rotating disc of selected watthour meter (mounted in center of circular housing) reflects beam of light on translucent circular scale; phototube detector and counter are used for counting revolutions of disc.

It has been known for many years that certain individual watthour meters may exhibit remarkable stability over long periods of time. Thus, in an effort to develop a more rapid testing procedure, it was decided to carefully select several watthour meters and to use them as a standard group for testing other watthour meters by a comparison of their rates.

The meter selected as a standard is a modified portable commercial watthour meter (rotating standard). This unit has been provided with a shaft extension, and its register has been removed. The meter is mounted in a temperature-controlled box (in center of large circular housing). A light-beam pointer has been provided by mounting a mirror inclined at 45 degrees on the upper end of the shaft. A beam of light incident vertically on the mirror is deflected horizontally to an encircling scale provided with a phosphorescent band. A phototube is placed behind a vertical slit in the phosphorescent band so that the light beam strikes the phototube once each revolution. The amplified pulse from the phototube energizes an electromagnetically operated mechanical counter for counting the number of complete revolutions of the disk of the standard watthour meter during a run.

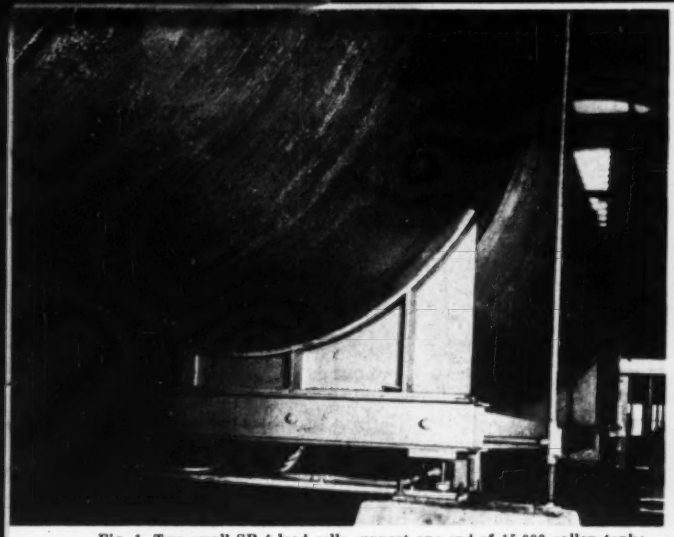


Fig. 1. Two small SR-4 load cells support one end of 15,000-gallon tank; other end has hinged support.

Fig. 2. Weight indications from load cells are recorded at production line.

AUTOMATIC TANK WEIGHING

J. A. OPENSHAW
Stanley Home Products, Inc.

PROBLEM resulting from the handling of increasing volumes of Freon for household products now contained in pressurized dispensers was solved recently at the Easthampton, Mass., plant of Stanley Home Products, Inc. by installation of a continuously-recording and weight-indicating system for the contents of two 15,000-gallon storage tanks.

The problem arose when rapidly growing demand for products such as insecticides, air fresheners, perfumes, lotions, etc. in self-dispensing pressurized cans required increasing quantities of Freon as the propellant. This pressurizing medium is a gas or vapor at normal atmospheric temperatures and pressures and has to be contained largely in liquid form under pressure until it performs its function in the hands of the ultimate consumer. Storage tanks are designed for 200-psi. pressure, but actual pressure is normally under 50 psi.

Efficiency in handling the large volumes of Freon in and out of the two storage tanks without loss presented a problem to plant engineers. When running a single mechanized production line at maximum rated capacity continuously for a week, more than 15,000 gallons of Freon would be used. This would require unloading two or three 6000-gallon tank cars. In using such large quantities of Freon, leakage and evaporation losses can be high unless unusual precautions are taken in unloading, in feeding production lines, and in guarding against system leaks.

A constant record of stored and used quantities of Freon is required. Weight is the only satisfactory measure of stored quantities because it is not affected by pressure and temperature. Although glass sight-gages are provided on the ends of the two tanks, they give only a rough check because volumes in the liquid and vapor phases vary widely with the quantity in the tank and its temperature.

The continuous weighing of the two tanks, which may weigh as much as 200,000 lb. each, was simplified by use of two small Baldwin SR-4 compression-type load cells of 50,000-lb. capacity each, as supporting members on the concrete base at one end of each tank (Fig. 1 and front cover). These cells use the Baldwin SR-4 resistance-wire strain gage. By leveling the 40-ft.-long, 8-ft.-diameter tanks the two cells support exactly half of the load, but the instruments are calibrated to read only the weight of the Freon in the tanks; the weight of the tank and supporting structure is zeroed out. The effects of connecting piping on weighing accuracy are eliminated by the use of reinforced flexible hose at both inlet and outlet. The resulting accuracy in weighing is within ½ of one percent.

Instrumentation provides for weight indications at three points. One of these points is beside the can filling position on the production line (Fig. 2). This is on a north wall of the building outside of which the two storage tanks are sheltered. The two instruments at this point are Baldwin strip-chart recorders with 1000-lb. divisions (approximately 85 gallons per division). Two indicating instruments with 5000-lb. divisions, the new Baldwin PTL meters are located on the outside of the same wall at a point between the two tanks. Two identical indicating instruments are located at the tank car siding at considerable distance from the storage tanks. The motor-driven pump at this outside location is under the control of the weighing system to the extent that it is shut down automatically when the weight of the storage tank corresponds to about 13,500 gallons of Freon. The tanks are never completely filled.

To fill the pressurized cans Stanley Home Products, Inc. has a new fast mechanized-production line. Cans can be filled with 10.2 oz. of Freon (chilled to minus 30 deg. F.) and sealed at the rate of 120 per minute. As the can is sealed within a few seconds after filling, the evaporation loss is small. At this rate Freon is taken from the tank at a rate approaching 5000 lb. per hour, or more than 37,000 lb. per 8-hr. shift.

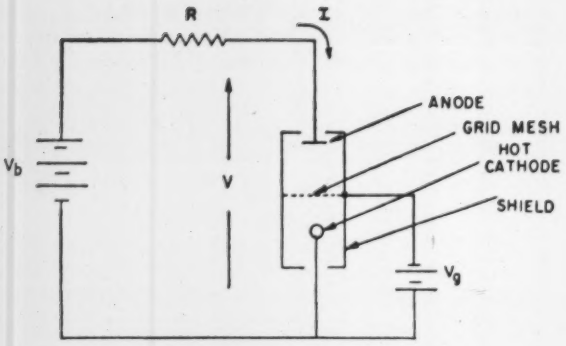


Fig. 1. Experimental tacitron circuit. Voltage across and current through tacitron is measured.

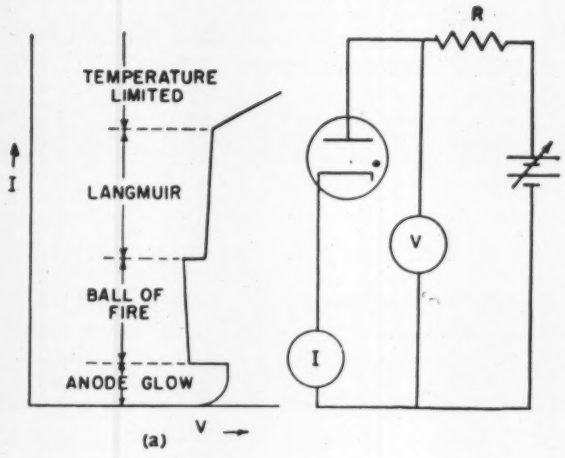


Fig. 2. Volt-ampere characteristic and various operation modes of conventional hot-cathode gas diode.

A low-noise grid-controlled thyratron--

THE TACITRON

Technique for obtaining anode-glow-mode operation in gas triodes overcomes the two basic disadvantages of thyratrons—noise and loss of grid control.

E. O. JOHNSON, J. OLMSTEAD and W. M. WEBSTER

RCA Laboratories Div.

A THYRATRON is essentially a triode vacuum tube filled with a gas such as xenon, argon, hydrogen, or mercury. Electrons en route from the cathode to the anode create ions which neutralize the electron space-charge. This makes possible the passage of large electron currents at low anode voltages, allowing the tube to operate with high efficiency. This important characteristic, combined with the simplicity, ruggedness, and high power sensitivity, has made the thyratron a popular device for diverse switching applications.

The thyratron has, however, serious disadvantages. Two very important ones are: (a) the tube is often noisy, and (b) once the anode current has started to flow it cannot be turned off by the grid. The latter difficulty has had to be surmounted by the troublesome expedient of first removing the anode voltage and then waiting for the tube to totally, or at least partly, deionize. This complicates the attendant circuitry and restricts the thyratron to relatively low-frequency applications.

Fundamental studies of externally-heated hot-cathode discharges have illuminated the way to a tube design that overcomes these two difficulties. This design insures operation in a unique discharge mode wherein ion generation occurs solely in the grid-anode region. This mode is stable, noiseless, and allows positive ion sheaths from a negative grid to span the grid holes and choke off the current. In practice this mode of discharge is achieved by proper selection of the size of the grid openings, gas, gas pressure, and over-all tube geometry. Aside from having a relatively opaque grid the tube is similar to conventional ones with respect to efficiency and operating conditions.

Abstracted from an article in the September, 1954 issue of Proceedings of the IRE.

Noiseless Operation

Studies of the discharge mechanism in hot-cathode gas diodes have defined four distinctly different modes in which the discharge may operate. Each of these is distinguished by the pattern of the observable glow and the interelectrode space potential. Generally, as the current in a hot-cathode gas diode is increased, the discharge will operate in one mode after the other in the idealized volt-ampere sequence illustrated in Fig. 2. The basic circuit for obtaining this sequence is shown in the same figure.

Commercial hot-cathode gas tubes normally operate in some combination of the first three modes, particularly the ball-of-fire and Langmuir, since the anode-glow mode is usually not found when the tube current is greater than several percent of the rated current. This is unfortunate because the anode-glow mode is the only one that can be relied upon for noiseless operation; the other modes are almost inevitably noisy and so unstable that the discharge usually jumps erratically from one to the other. Thus, the problem in getting noiseless hot-cathode gas-tube operation becomes one of finding how to make the tube remain in the anode-glow mode up to appreciable currents. A detailed analysis of the anode-glow mode shows that it has

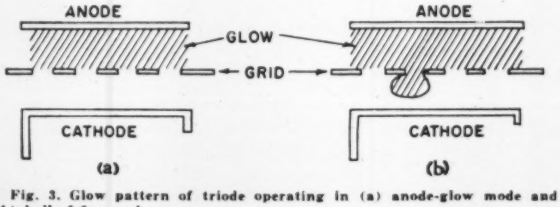


Fig. 3. Glow pattern of triode operating in (a) anode-glow mode and (b) ball-of-fire mode.

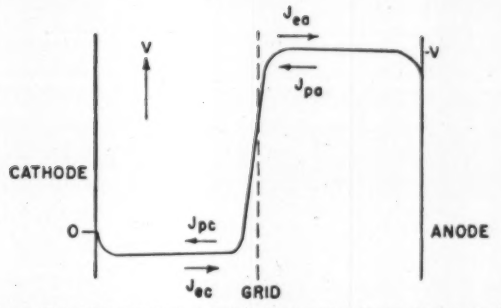


Fig. 4. Potential distribution in triode operating in anode-glow mode.

the electrical characteristics of a nonlinear positive resistance with no obvious tendency for instability.

Visually, the anode-glow mode in these tubes is manifested by a glow which closely hugs the anode (Fig. 3).

Tacitron Mode

The potential diagram in Fig. 4 corresponds to the anode glow, or quiet, mode which will hereafter be referred to as the "tacitron" mode to avoid confusion with anode-glow mode in diodes. There are two regions of plasma* in this discharge. The one in the cathode region has a potential slightly negative with respect to that of the cathode; the one in the anode region has a potential about equal to that of the anode. The conditions in the cathode-grid plasma are identical to those in the anode-glow plasma of the diode. The ions which supply this plasma are generated in the grid-anode region and fall through the double sheath which exists in the plane of the grid wires.

In an ordinary thyratron, the grid generally has one or a few large apertures and the discharge will operate in the tacitron mode for currents which are only a few percent of the rated current. If, however, the grid is made to have a large number of small holes, whose size is properly related to the gas, gas pressure, and over-all tube geometry, noise-free conduction in the tacitron mode can be obtained up to much larger currents and, in addition, the grid cutoff action at substantial values of plate current is possible.

As for mechanical construction, tubes with the noiseless feature are no more difficult to fabricate than other gas tubes. Care has to be taken, however, to insure that there are no holes or spaces along the edges of the mesh grid that have a major dimension larger than the mesh holes. Compared to the other possible discharge modes for a three-element hot-cathode gas tube, the tacitron mode possesses three important advantages with respect to current cutoff. These are: (a) the ion generation mechanism is such that the feedback action on the sheath expansion process seems to be a minimum, (b) the sheath expansion takes place in a plasma which is characterized by low particle-density and low electron-energies, and (c) the tube current and plasma density are distributed evenly over an interelectrode path of relatively large area.

*Plasma is a region in which both positive ions and negative electrons exist. Recombination of ions and electrons produces a characteristic glow.

Time-proportional Thermostat

WASHINGTON, D. C.—A versatile electronic thermostat has been developed by F. A. Ransom of the NBS electronic instrumentation laboratory. The device features (1) small dead zone; (2) high sensitivity without loss of stability (3) can control power from milliwatts to kilowatts; (4) use of sensing elements which may be a resistance thermometer or a thermistor connected in a bridge circuit, or a thermocouple connected to a chopper circuit; and (5) use of standard commercial components. The power supplied to the heating element is switched on and off in a regular cycle, but the fraction of the cycle during which the power remains on is proportional to the deviation from the desired temperature.

The resistance thermometer or thermistor is connected in one arm of an a-c. bridge. The adjacent arm of the bridge is a variable resistor adjustable to the desired temperature control point. A 164-cps. oscillator energizes the bridge and also supplies synchronizing voltage to a twin-diode synchronous detector.

Also applied to the detector, in series with the error voltage, is a voltage from a sawtooth oscillator. The result is that the output of the detector consists of a sawtooth voltage that operates about a reference level which varies with the error voltage. This detector output is applied to a Schmitt trigger circuit, which in turn actuates a relay that switches the power applied to the control heater.

The duty cycle, determined by the frequency of the sawtooth oscillator, is designed to be adjustable over a range of about 5 to 15 seconds to meet the needs of any particular controlled process. In a typical NBS application the thermostat has for many months held standard electric cells, immersed in an oil bath, to a controlled temperature of 28 deg. C. within ± 0.001 deg. C.

Another use of the instrument has been in a small electrical furnace. The typical small heated-air oven is ordinarily difficult to control because of its low thermal inertia. Using the NBS thermostat, the temperature was maintained to within ± 0.1 deg. C. over a range from 250 to 450 deg. C.

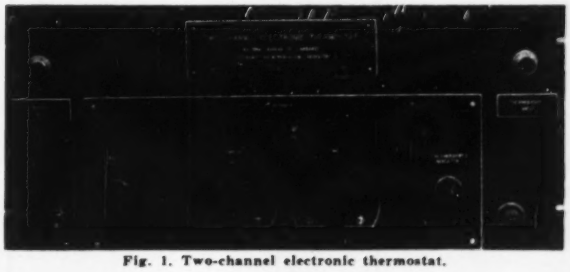


Fig. 1. Two-channel electronic thermostat.

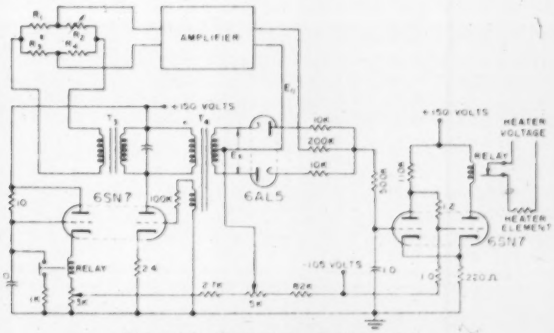


Fig. 2. Circuit of electronic thermostat.

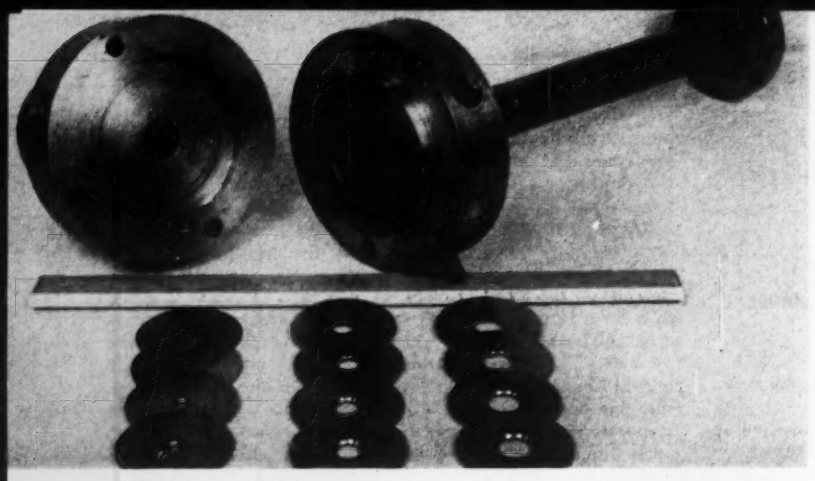


Fig. 1. Orifice plates and meter tube used for testing effect of edge thickness and edge sharpness on flow coefficient.

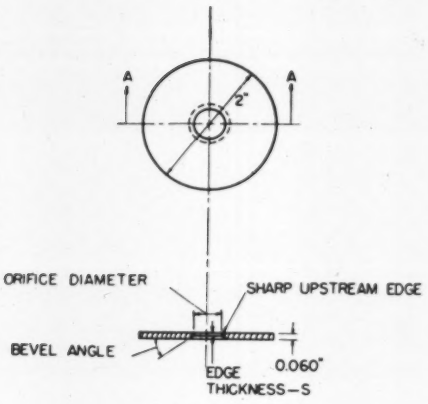


Fig. 2. Orifice-plate notation.

Effect of Edge Thickness on

SMALL ORIFICE METERS

Orifice plates with various edge thicknesses were tested in a ¾-inch-diameter tube using water. A plot of discharge coefficients as a function of Reynold's number shows that if the edge thickness is greater than 1/40 of the pipe diameter, the discharge coefficient increases with edge thickness. The increase in coefficient is greater at low Reynold's numbers.

L. W. THRASHER and R. C. BINDER

Purdue University

DISCHARGE COEFFICIENT of an orifice meter is influenced by various factors—meter configuration, orifice-plate dimensions, and piping details upstream and downstream from the meter. For orifices in pipes two inches in diameter and larger, the influence of these factors is comparatively well established, but for smaller pipe sizes there is little information on the effects of different orifice details.

The effect of edge sharpness was reported recently*; the effect of edge thickness is presented in this study. Fig. 1 illustrates orifice plates and meter tube used; Fig. 2 shows orifice-plate notation.

Test Setup

Fig. 3 shows the test apparatus—a supply tank, a centrifugal pump to circulate water, a ¾-inch-diameter meter tube, a manometer for measuring the pressure differential across the orifice plate, weighing and timing equipment to determine the weight rate of flow, and a nickle resistance-thermometer and Wheatstone bridge to measure water temperature.

Forty pipe-diameters of standard ¾-inch galvanized-steel pipe preceded the meter. The pipe and meter ends butted together in flanged fittings to minimize upstream and downstream disturbances. The total undisturbed pipe-length upstream from the orifice plate was 55 pipe diameters. The resistance thermometer element was inserted nine pipe-diameters downstream from the orifice plate.

Three sets of five stainless-steel orifice plates each were tested (Fig. 1). All five plates in a set had nearly the same orifice diameter. One set of plates had beta ratio of 0.2; the second set had a beta ratio of 0.5; the third set had a beta ratio of 0.7.

Each of the three sets of plates having the same orifice diameter were made in the same way. Both surfaces of each of the five plates were turned and lapped parallel, the plates were clamped together with an extra plate at each end of the stack, and the orifice was bored through the entire stack of plates. While the stacks of plates having diameter ratios of 0.5 and 0.7 were still clamped together, the hole was lapped with a brass rod and fine abrasive in order to remove the marks of the boring tool. The end plates were then discarded. The set with diameter ratio of 0.2 was not lapped. For this set, the cylindrical length of the orifice seemed smooth to the naked eye, but under a microscope the spiral grooves from the boring tool were visible. The individual orifices were beveled at 45 degrees to the downstream surface of the plate in order to obtain the various edge thicknesses. Edge thicknesses in each set of five plates were 0.060, 0.040, 0.020, 0.010, and 0.005 inch. Under a magnification of about thirty diameters, the upstream edges of all orifices within a set appeared to have the same degree of edge sharpness.

*Huffman, Thrasher, and Binder; "Effect of Edge Sharpness on Small Orifice Meters," *Instruments & Automation*, September 1954, p. 1468-69.

Test Results

Discharge coefficients (C) versus the pipe Reynold's number (N) for the three diameter ratios were plotted (Figs. 4, 5, and 6). As the data for the plate with beta ratio of 0.2 and an edge thickness of 0.060 inch were badly scattered and from ten to fifteen percent higher than the data for the other four plates with the same beta ratio, the test results for that plate were discarded.

The results show that the discharge coefficient increases as the edge thickness increases, and that the increase in coefficient became greater as the Reynold's number decreased.

Owing to the small differences between coefficient values for plates having different edge thicknesses, a statistical study of the data was made to determine whether the small differences could have occurred by chance alone. The analysis indicated the following: For a diameter ratio of 0.2, there were no significant differences in coefficient data for the different plates; for a diameter ratio of 0.5, only the plates with edge thicknesses of 0.060 and 0.040 inch were significantly different from the plate with an 0.005-inch edge thickness; and for a diameter ratio of 0.7, only the plate with an edge thickness of 0.060 inch was significantly different from the plate with the 0.005-inch edge thickness. Any other differences in the data between plates might well have occurred by chance alone.

Accuracy

The uncertainty of the data is believed to be plus or minus 0.3 percent. For a given plate, the scatter in the data is plus or minus 0.3 percent or less.

Conclusion

The tests indicate that if the orifice edge-thickness is less than 1/40 of the pipe diameter, edge thickness has no effect on the discharge coefficient. Greater edge thicknesses increase the discharge coefficient. The increase in coefficient becomes larger as the beta ratio decreases, and as the Reynold's number decreases.

The effect of edge thickness can be treated by two methods: (1) Basic discharge coefficients can be given for orifices with edge thicknesses less than 1/40 of the pipe diameter and (2) for orifices with thicker edges, correction factors can be applied to the basic coefficients. As the effect of edge thickness varies with both beta ratio and Reynold's number, method (2) may be complicated. If the maximum edge thickness can be specified as 1/40 of the pipe diameter, then the basic discharge coefficients would not apply to orifices with thicker edges. The latter method is used for orifices in larger pipes [2], is the simpler of the two methods, and is recommended.

Acknowledgment

The authors are grateful to Dean G. A. Hawkins and Professor H. L. Solberg, of Purdue University, for making available the facilities for these tests. Some material in this paper was adapted from a Ph. D. thesis [3].

Bibliography

1. Huffman, G. C., "Investigation of Small Orifice Meters," Ph. D. Thesis, Purdue University, February, 1953.

2. "Flow Measurement by Means of Standardized Nozzles and Orifice Plates," ASME Power Test Codes Supplement on Instruments and Apparatus, Part 5, Chapter 4, 1949.

3. Thrasher, L. W., "The Effects of Edge Thickness and Edge Sharpness on Small Orifices," Ph. D. Thesis, Purdue University, August, 1954.

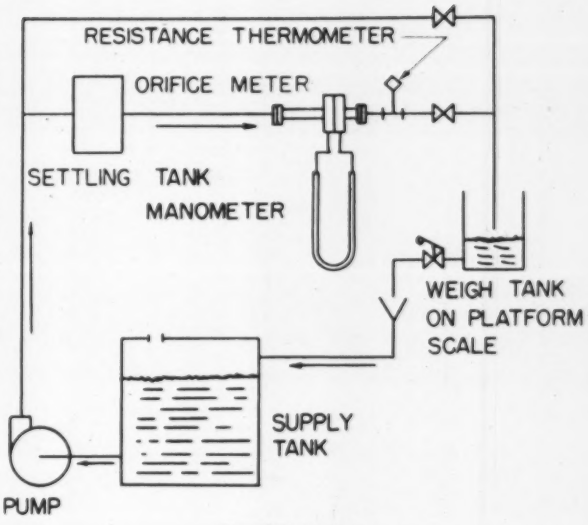


Fig. 3. Test set-up.

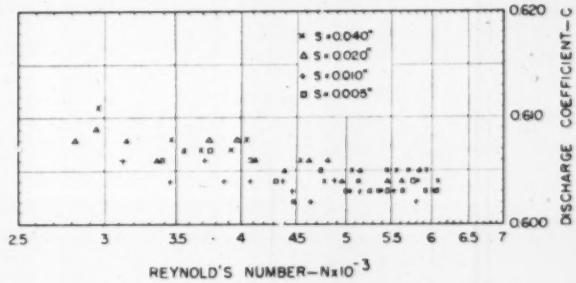


Fig. 4. C vs. RN for plates with beta ratio of 0.2

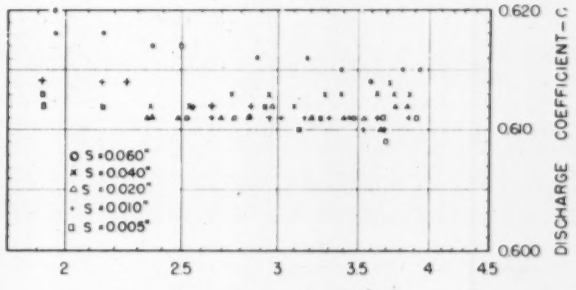


Fig. 5. C vs. RN for plates with beta ratio of 0.5

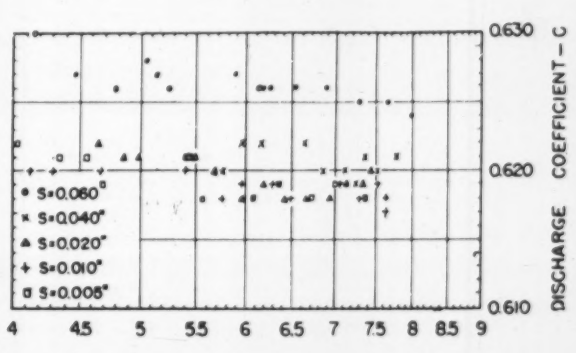


Fig. 6. C vs. RN for plates with beta ratio of 0.7

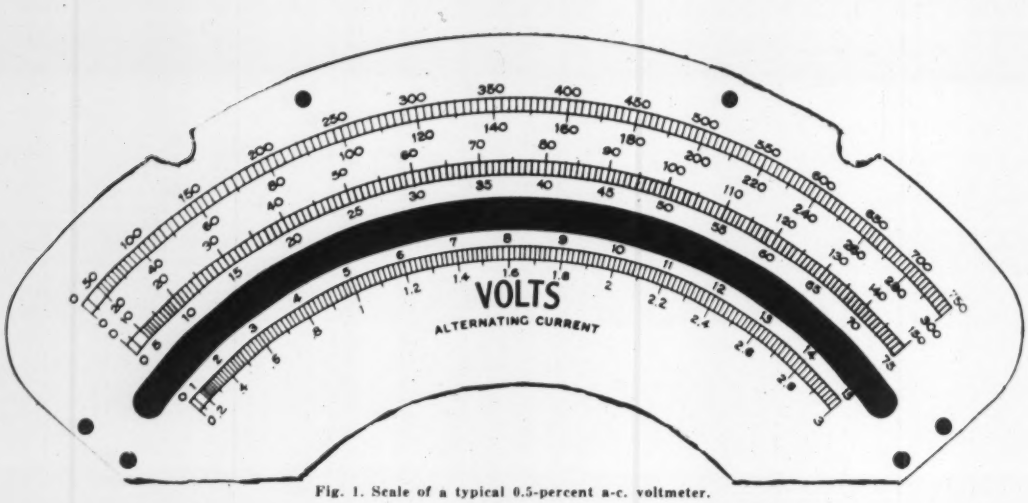


Fig. 1. Scale of a typical 0.5-percent a-c. voltmeter.

Scale and Reading Errors of

ELECTRICAL INDICATORS

Scale and reading errors limit the accuracy of even the best electrical indicating instrument to about 0.1 percent. Sources of errors are analyzed, and the NBS standard calibration methods are presented.

FRANK D. WEAVER
National Bureau of Standards

THE SCALE of an electrical instrument is an important component; a poor or defective scale can result in errors greater than that claimed by the manufacturer.

An evenly divided scale is desirable. However, if the same percentage accuracy of reading the measured quantity is desired at all points, the divisions should be wider at the beginning than at the end of the scale.

As most types of instruments cannot be designed to have operating and control torques that balance to permit the same percentage of accuracy of indication at all points on the scale, it has become common practice to refer to percent of error and accuracy class in terms of full-scale reading. This convention implies that the indication of an instrument with 0.25-percent accuracy and a 100-division scale may deviate from the true value by 0.25 division at any reading along the scale.

One of the prerequisites of a good instrument is that its scale be calibrated accurately—that is, the cardinal scale marks must be located correctly and the intermediate division marks must not be out of position by more than the desired accuracy. These marks may be out of place because of (1) errors in the reference instrument used originally for calibrating the scale, (2) random errors in locating the cardinal points, (3) failure to subdivide between cardinal marks in accordance with the scale law, (4) erratic spacing of the subdivision marks between two adjacent cardinal points, and (5) changes that have occurred in components since the original calibration.

In order that the pointer indications may be read accurately, a high-grade instrument should have an anti-parallax mirror and a knife-edge pointer with the knife-edge about equal to that of the division lines, and preferably not more than 1/10 that of the distance between two successive scale division marks. These scale division marks should be at least 1 mm. apart.

For the better grades of portable instruments with which this article is concerned it is a customary practice for the manufacturer to fit the scale to each individual instrument. A blank scale is put in place and cardinal points are marked on it to correspond to values determined with an accurate reference standard. After the cardinal marks are ruled on the scale the intermediate division marks between pairs of cardinal marks are located by a mechanical subdivision device. If an accurate dividing machine is not used there may be a noticeable variation in the spacing of subdivision marks. Some instruments show errors of several tenths of a percent because of carelessness in spacing of the ruled subdivision marks.

Scale Errors

Electrical instruments that come to the National Bureau of Standards for standardization tests are ordinarily tested at five of the cardinal points on the scale (20, 40, 60, 80, and 100 division points on a 100-division scale; 30, 60, 90, 120, and 150 division points on a 150-division scale) and, upon request, at each of the cardinal points. Unless the customer uses the instru-

Fig. 2. Enlarged portion of middle scale of Fig. 1.

ment at only the points tested the question arises as to the corrections for the other scale points. In the absence of further tests it is generally considered that the best value for the other scale points is obtained by linear interpolation (graphically) of the corrections for the five or ten points tested. Then the question arises as to the validity of the interpolated values—in other words, how close is the interpolated value to the true value.

Some electrical instruments that are sent to the laboratory reveal, upon a visual inspection of the scale, a noticeable inequality in the spacing of adjacent subdivision marks.

To study this a number of instruments of different manufacturers were tested at each scale division throughout the usable or upper part of the scale. Both angular measurements and a test at each division mark were made on a number of instruments; 39 instruments of 8 different manufacturers were included in tests. Of these, 15 were of the electrodynamic type, 4 of the moving-iron and 20 of the p-m. m-c. types. There were eight laboratory standards (0.1-percent-accuracy class) and the rest were in the 0.5-percent-accuracy class or better. Of these, 22 were tested at each of the scale divisions over the usable part of the scale. The p-m. m-c. and electrodynamic types were tested with a potentiometer and its accessories; the moving-iron type was tested with a transfer instrument. It is believed that for a good instrument with a good scale the values obtained by setting the pointer over a scale division mark in our usual testing procedure are correct within about 0.02 division.

The illustrations show some of the scale characteristics of some of the instruments tested. Fig. 1 shows a scale for one instrument. Fig. 2 is an enlargement of the upper portion of the middle scale of the same instrument. Fig. 3 gives the corrections that must be applied to the several division marks of the same voltmeter (150-volt range) to give the true value for each of these points. Fig. 4 is a correction graph for another typical instrument. The broken lines show the errors that result if the common linear interpolating procedure is followed after testing at five of the cardinal points.

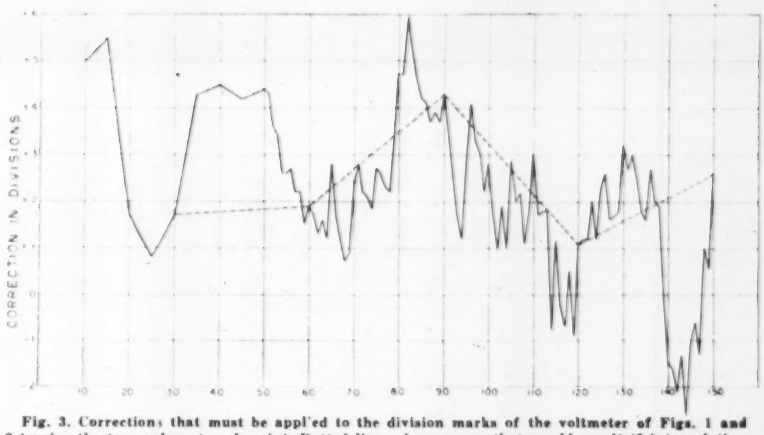


Fig. 3. Corrections that must be applied to the division marks of the voltmeter of Figs. 1 and 2 to give the true value at each point. Dotted lines show errors that would result if interpolating procedure is followed after basic NBS test at 5 cardinal points.

The magnitude of the irregularities may in some instances be influenced by the observers incorrect setting of the pointer over the division mark, or by pivot friction. However, it is believed that errors from these two sources have been held to a minimum.

No attempt will be made here to identify the particular influencing factors that cause the large errors indicated by some of the graphs. Self heating errors probably have considerable effect on the general shape of the correction curves in those instruments that are not well temperature-compensated.

Figs. 1 and 2 indicate that some of the irregularities in the correction graph of Fig. 3 are due to the irregular spacing of the subdivision marks on the scale of this particular instrument.

Note that Fig. 4 also shows the relationship between divisions and degrees of the instrument scale.

Errors of Observation

Observational errors usually result from (1) misreading the scale, (2) failure to eliminate parallax on reading and (3) failure to estimate correctly fractional divisions. The first may be minimized by careful attention on the part of an observer in taking readings. The parallax error is effectively eliminated by the correct use of anti-parallax mirrors and other optical devices.

A number of studies have been made on the accuracy of estimates of fractional divisions. A Swedish scientist, Backstrom*, made one of the most thorough studies on this subject. His conclusions may be summarized as follows: (1) the estimation of any particular observer cannot be depended upon to be accurate to the nearest tenth of a division except at the division

* Backstrom, H. E., *Zeit. f. Instrumentenkunde*, Vol. 50, p. 561-75, 609-624, 665-679, 1930, and Vol. 52, p. 105-123 and 260-274, 1932

Fig. 4. Scale characteristics of an a-c. and d-c. wattmeter of 0.1-percent accuracy class.

marks themselves and at the midpoint of the division, (2) an individual will make estimations of tenths of a division in much the same manner over long time intervals, (3) the minimum error occurred when the line width was equal to the pointer width, and each was roughly 0.1 that of a division width, and (4) the average error of estimation decreased with increasing division width. There was little gain in increasing the width beyond about 2 mm.

In the ordinary procedure of reading an instrument scale an observer will estimate the pointer position to the nearest 0.1 scale division. Backstrom's study and our experience indicate that the accuracy with which one is able to estimate depends on a number of the factors. It is assumed that the observer has normal vision, that the instrument has a good scale and pointer, and that the scale is well illuminated. The influencing factors are then (1) width of scale marks and width of pointer, (2) distance between scale marks, (3) the particular tenth which is being estimated, (4) fatigue and physical condition of the observer, (5) color combinations for scale, pointer and lines, and (6) personal bias.

We tested the ability of our laboratory personnel to estimate pointer positions. A 100-v. d-c. voltmeter in the 0.5-percent-accuracy class, and an a-c. and d-c. 150-v. voltmeter in ¼-percent-accuracy class were selected for the test. The interval between the 80 and 81 division marks on the d-c. voltmeter and the 120 and 121 division marks on the a-c. and d-c. voltmeter was selected for the experiment. Each instrument was carefully tested at its two chosen reference division marks with a potentiometer. The obtained values then were used as a basis for dividing the intervening space into twenty equal intervals. An observer at the potentiometer adjusted the voltage to set the pointer in random order to the various tenths or twentieths of a division. Most of the subjects had considerable previous experience reading instruments. As indicated in the table, each was asked to estimate to the nearest tenth (and in other tests to the nearest twentieth) of a division. The subject was not aware of the setting being made at the potentiometer nor was he told how close his estimated values were to the true values until the test was finished.

In obtaining the data for the table, the pointer was set to each 0.05 position and the observer was asked to estimate to the nearest 0.1. For the 0.05, 0.15, 0.25, 0.35, and 0.45 positions he most frequently estimated the 0.1 below the value set (for 0.45 he estimated 0.40), and for 0.55, 0.65, 0.75, 0.85, and 0.95 positions he most frequently chose the 0.1 above the value set (for 0.85 he estimated 0.90).

In further tests, a flat-field x2 lens, 1⅜ inches in diameter, was used, and each observer was asked to estimate to the nearest 1/20th of the scale interval. For most observers, this lens materially aided estimational accuracy.

The results indicate that an observer generally can estimate on a good scale to within 0.1 scale division. Out of 945 estimations only 25 were in error by as much as 0.15 division, and 123 (about 13 percent) were in error by as much as 0.1 division. The greatest uncertainty of estimation appears to be in the area of 0.3 and 0.7 division.

Table.—Estimation of pointer position of a-c. and d-c. voltmeter to nearest 0.1 division, 14 observers, no lens used.

Pointer Position Set in Divisions	*Estimations*									
	−.25	−.20	−.15	−.10	−.05	Correct	+.05	+.10	+.15	+.20
120.00						14				
.05					9		5			
.10				4		10				
.15			1		6		7			
.20				6		8				
.25					6		8			
.30				4		10				
.35			2		5		7			
.40				2		11		1		
.45			1		8		5			
.50				2		9		2		1
.55	1				2		10		1	
.60				1		7		5		1
.65			1		1		10		2	
.70		1		1		7		5		
.75			1		2		10		1	
.80				1		6		7		
.85					3		9		2	
.90						9		5		
.95					2		12			
121.00						14				

Conclusion

The data indicate that some instruments in the better-accuracy class have inaccurately marked scales. If these instruments are tested at five of the cardinal points, values obtained by applying corrections to the scale indications at intermediate points may be expected to be in error by several tenths of a division when the corrections are obtained by linear interpolation between values reported at the cardinal points.

It is possible to draw two conclusions: (1) If the corrections at five of the cardinal points are plotted on a graph, as in the figures, and the broken line connecting all plotted points is abnormally irregular, it is unlikely that interpolation between two adjacent cardinal points will give correct values. (2) If the spacings between adjacent division marks when viewed with the eye appear to be of unequal widths it is also unlikely that an interpolation value will be valid.

If an instrument is tested at every five divisions on its scale and the separation of intermediate marks appear normal the interpolation procedure should give values that are reasonably correct. Thereafter it should be necessary to test it only occasionally at five of the cardinal points. If the scale does not meet the necessary accuracy requirements (adjacent intermediate division marks are irregularly spaced or cardinal points are incorrectly placed) it may be advisable to return the instrument to the manufacturer for a new scale.

The procedure of estimating tenths of a division is not the weakest link in electrical measurements. However, this factor combined with a large number of other possible sources of error limit the accuracy of even the best instrument under ideal conditions to about 0.1 percent. If greater accuracy is desired one should resort to potentiometric measurements.

Instrumentation of Modern

BY-PRODUCT COKE OVENS

The control system for the three modern coke-oven batteries of Stelco includes control of (a) fuel-gas pressures, (b) stack draft, (c) exhausters, and (d) boosters. Pneumatic techniques are used.

E. T. W. BAILEY

The Steel Co. of Canada, Ltd.

SINCE May, 1948, the Steel Company of Canada, Ltd. has brought into production three batteries of coke ovens composed of 61, 83, and 47 ovens, respectively—a total of 191. The ovens are designed for underfiring with either blast-furnace or coke-oven gas; provision is made for limited cross mixing.

The complement of instruments and controls for these ovens follows the general pattern of other similar installations. Therefore, this discussion presents unusual features, and only lists the units which are common in function and type.

List of Instruments

PRESSURE REGULATORS: Blast-furnace fuel gas; coke-oven fuel gas; stack draft; collector main; exhauster inlet; coke-oven gas bleeder.

FLOWMETERS: Coke-oven fuel gas; coke-oven gas for enrichment; total coke-oven gas produced; blast-furnace fuel gas; steam; coke-oven gas bled.

PRESSURE RECORDERS: Two fuel gases; collector mains; basement air; cross-over mains.

TEMPERATURE RECORDERS: Stack gases; coke-oven fuel gas; gas in cross-over mains.

MISCELLANEOUS: Pressure and temperature indicators; calorimeter for blast-furnace gas; blast-furnace gasholder position indicator; portable pyrometers; test pressure gages; Orsat and combustible-gas indicator.

Pneumatic Operation

Compared with other coke ovens, the chief difference to be found in the Stelco installation is that all the controllers are pneumatically powered and operated. The occasional interruption in electric power, the extra cost to provide mains and steam-driven oil pumps, together with the number required because of the long distances between control-valve locations, were some of the reasons for choosing pneumatic operators. Also, the history of no complete compressed-air failures in the plant in over 25 years influenced the decision to depend on this source of power.

One standby air compressor for instruments was installed to be a second line of defense in event of possible plant or local failure of air pressure. It could also be used for planned interruptions of compressed-air supply. Pneumatic controllers of various makes and types were in service in several other departments; instrument craftsmen were familiar with them and liked their speed, adjustability, and cleanliness.

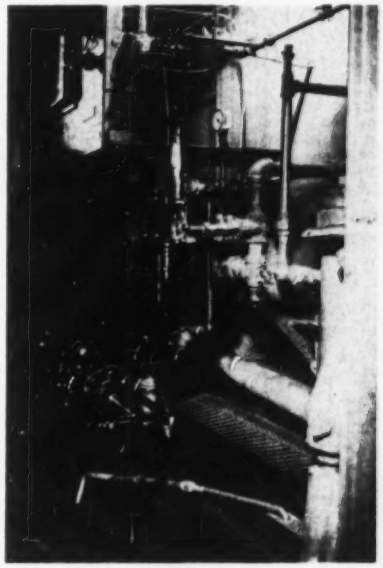


Fig. 1. Power cylinder at one of the cross-over mains. A turnbuckle (below) permits adjustment of the control butterfly valve. Cylinder linkage is shown disconnected so turnbuckle can be seen.

In practice, the controls have met the demands imposed upon them well. Among the features liked best are:

(a) The arrangement whereby the controller can be by-passed at the manual-automatic station and movement of the power cylinder and control valve thereby transferred to the operator. This enables repairs, alterations, or inspections to be made to the controllers and is worthwhile in view of the 365-day per year continuous schedule practiced at all coke ovens.

(b) The coke ovens are in a dusty area and pneumatic controllers require less cleaning. Oil-hydraulic controllers of various makes are in operation in other locations in the plant and, although they generally perform faithfully, they look dirty most of the time.

(c) Leaks from oil-operated controls have caused a few fires and one feels better when this hazard is not a factor at or near the coke ovens.

(d) Power cylinders can be serviced by means of a turnbuckle arrangement by which adjustments can be made to the control butterfly valve by manually changing the turnbuckle. Fig. 1 shows a power cylinder so equipped and located on one of the cross-over mains.

About the only trouble experienced was at the start, when the newness and close fit of a few pilot valves on the receiving regulators caused them to stick. This was remedied quickly and is now rare.

The compressed air is normally taken from the plant system. It is all filtered before entering the compressors. As it enters the piping system serving instruments and controls it passes through a "Condensifilter" followed by a drip tank. Each branch pipeline has inserted a swing-bolt-type felt-cartridge filter. The separate pipelines serving

Presented at Conference on Instrumentation for Iron & Steel Industry, Pittsburgh, March 25, 1954.

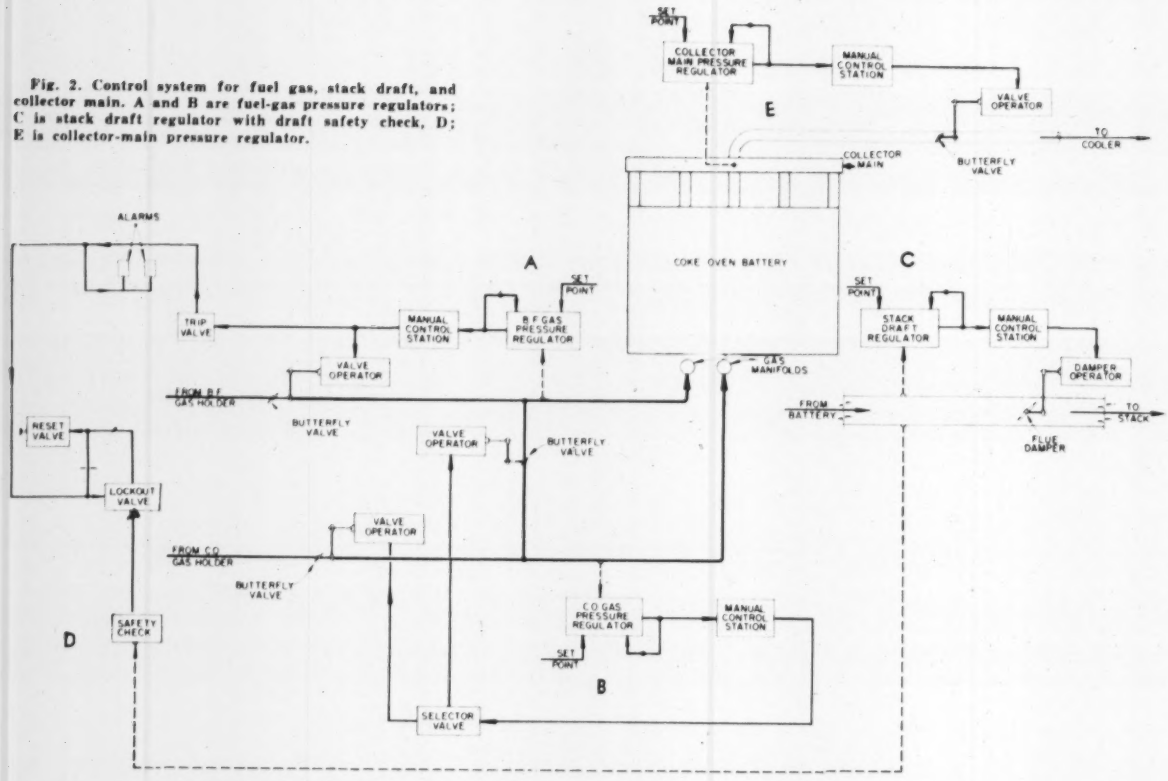


Fig. 2. Control system for fuel gas, stack draft, and collector main. A and B are fuel-gas pressure regulators; C is stack draft regulator with draft safety check, D; E is collector-main pressure regulator.

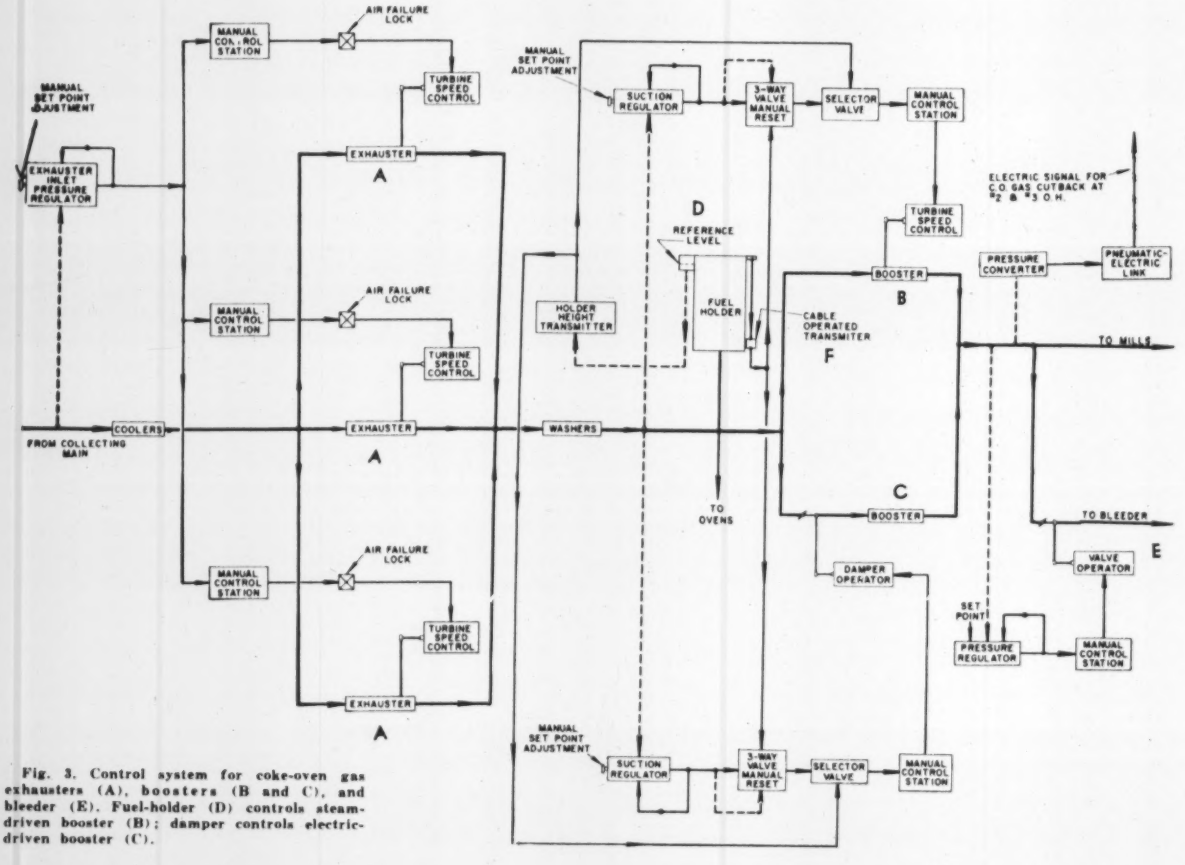


Fig. 3. Control system for coke-oven gas exhausters (A), boosters (B and C), and bleeder (E). Fuel-holder (D) controls steam-driven booster (B); damper controls electric-driven booster (C).

each controller have smaller filters. Practically no trouble is experienced from dirt or moisture in the compressed air.

The control system is shown in Fig. 2. The controllers used for holding constant pressure of both fuel gases are standard pneumatically-operated pressure controllers.

Both the blast-furnace and coke-oven gas are held within plus or minus 1-mm. water pressure of the set point by pressure regulators (A and B in Fig. 2).

Stack Draft

Control of stack draft on a battery of coke ovens is important. Failure of the damper to open after a reversal, where blast-furnace gas is used to underfire, can and has resulted in basement explosions in other plants. In order to protect against this misfortune, a draft safety check—complete with lockout reset valves and alarm, actuates a trip valve which overrides the blast-furnace-gas pressure impulse and closes the control valve in that fuel main. This means of protection is preferable to placing stops on the draft-damper-drive arm because such stops would have to be relocated depending on which fuel was being used to underfire the ovens. Blast-furnace-gas fuel, with its high percentage of inerts, requires a stop setting further from the closed damper position than is required when coke-oven gas is the battery fuel. The operator would have to remember to change these stop locations each time the character of the fuel was changed. A control device would be more dependable because the operator has a lot to do at such times, or he may be new or a relief man not familiar with the need for such a change.

The damper operator is an 8-in. x 20-in. cylinder that drives a butterfly-type damper with a vertical shaft. Draft is held to within less than plus or minus 0.5 mm. water of the set point.

Collector-main Pressure

The collector-main pressure has to be controlled carefully. Usually this pressure is held within plus or minus 1-mm. water of the set point, except on windy days when it may be slightly more. This controller has to correct for variations in (1) pressure set up by wind velocity around the battery, (2) gas volume produced as each oven is pushed and/or charged, (3) pressure at the exhausters, whether caused by steam supply or other factors in the system, and (4) stack draft and reversals of the fuel gases. It is one of the most active controllers in a plant, and it has to be good.

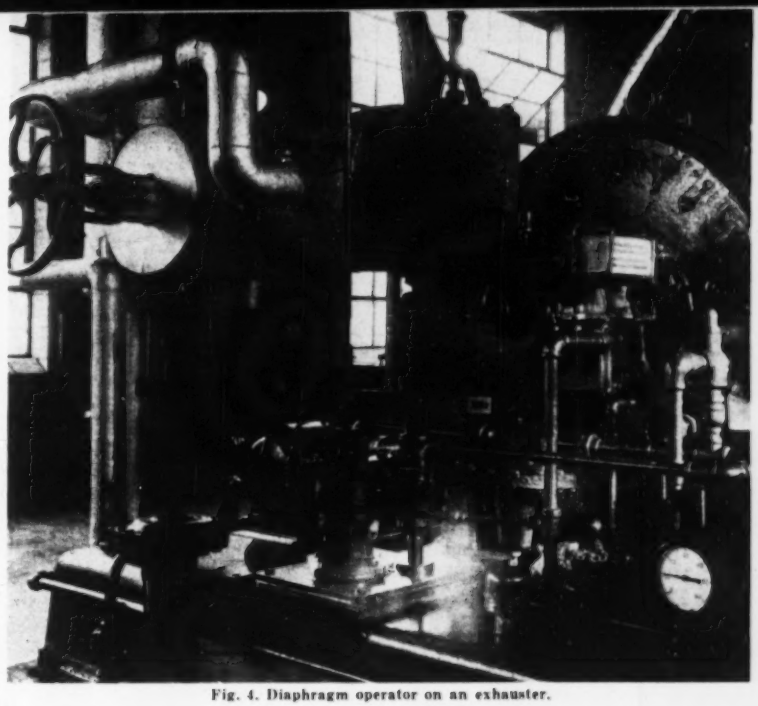


Fig. 4. Diaphragm operator on an exhauster.

Exhauster Control

The gas pressure at the inlet to the exhauster (A in Fig. 3) is controlled to within plus or minus 10-mm. water variation. The controller, through a diaphragm operator, actuates the oil relay governor on the turbines driving the exhausters. Usually only one exhauster is placed on active control while the others are base loaded. Fig. 4 shows the diaphragm operator on an exhauster. All exhauster controls are equipped with manual-automatic stations.

Booster Control

The boosters (Fig. 3) which deliver the gas to the plant-fuel-distribution system have their capacity controlled from the height of a 20,000-cubic-foot coke-oven-gas holder (D) used to take up part of the gas released during reversals. A steam-driven booster (B) is controlled in the same manner as the exhausters. An electric-driven machine (C) is controlled as to output by a butterfly valve in the inlet. This has at times created a high vacuum in the inlet and caused the motor to kick off the line. Adjustment of the oil level in the fluid drive is being considered as a better means to control this booster.

The scheme of controlling booster capacity from the height of a small holder floating on the inlet main was started when the large storage holder was removed to make room for new blast-furnace slag pits. It was not replaced.

The primary control uses a neoprene hose tied to a travelling reservoir at the top of the holder lift. This hose is filled with kerosene which imposes a head pressure (directly proportional to the holder height) upon a signal transmitter. This transmitter sends out a loading pressure which governs the booster turbine speed. Should the send-out pressure exceed 53 psig. (indicating trouble in the system) three-way weight-loaded valves, with manual reset, automatically switch the control impulse to a second holder height-transmitter-operated from a cable (F in Fig. 3). This functions as a second line of defense.

Should this signal prove unsuitable a third line of defense is provided whereby the operator can cut in pressure controllers which will adjust the booster turbine speeds to hold a constant inlet pressure. He has to watch this setting and adjust it so that the small holder will always be positioned to take care of normal battery-reversal conditions.

To date we have had excellent results from this control scheme. The controllers have to work fast when the batteries are reversed when underfired with 100-percent-coke-oven gas. The batteries are timed so as not to reverse together.

Among the secrets of keeping pneumatic controls operating free from freezing troubles is to see that they and the tubing transmitting air are kept warm with either steam or hot-bed cable tracers. Carefully installed, they give reliable and dependable service.

A Stable Noise-Generator

Inherent noise of a thyratron prevents generation of a stable noise signal. A thyratron plus an AGC-controlled amplifier gives a stable noise signal. Circuit design factors are included.

J. D. SHAFFER
The Pennsylvania State University

ULTRASONIC-NOISE GENERATORS employing thyratrons as the noise source and a linear amplifier for increasing the noise level are not sufficiently stable for unmonitored instrument applications. The undesirable characteristics of such sources include (1) day-to-day output variations, (2) long warm-up period for output stabilization, (3) drift in output level after warm-up, and (4) tendency toward oscillation. A program was set up at the Ordnance Research Laboratory, The Pennsylvania State University, State College, Pa., to determine to what extent these undesirable characteristics could be reduced through proper selection of tube type and circuit.

The first tests were made to select the type of thyratron tube best suited for use in such a generator. As the noise signal was to be filtered to a relatively narrow bandwidth, the possibility of an uneven spectrum over the narrow band was not considered. Also, as the range of filter center frequencies was such as to reject frequencies usually associated with plasma oscillations, no external magnetic-field stabilization was used. Tube types 2050, 2051, 884, 6D4, and 2D21 were connected as in Fig. 1, and their behavior for a ± 50-percent change of 230-volt plate potential was measured. The 2D21 proved to be the most stable of the tubes tested, exhibiting the least variation in noise-signal output and the least tendency toward oscillation.

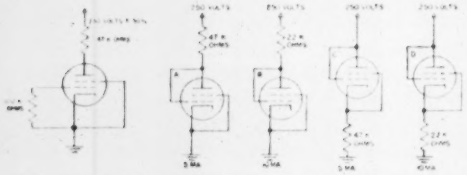


Fig. 1. (left) Circuit used to check performance of various tube types. Fig. 2. (right) Four arrangements used to establish most stable 2D21 circuit.

To find the circuit that would minimize noise-level variation from tube to tube and also the tendency toward relaxation oscillation, thirty-nine 2D21's picked at random from stock were connected in each of the four circuits shown in Fig. 2. After a warm-up period, the noise level from each tube was monitored at the output of a narrow-band filter centered at approximately 50,000 cps. These tests indicated that the most stable performance was produced by a 2D21 tube with a 47,000-ohm resistor in the cathode circuit and 250 volts at the plate. Further tests in which the heater and plate voltages were varied confirmed that the most stable performance is achieved through use of a 47,000-ohm cathode resistor and a plate voltage of 250 volts.

This circuit was used in tests to determine the effects of temperature and aging. Temperature was measured at the mid portion of the glass envelope of the 2D21 tubes. Aging tests were run for 600 hours. In all tests, the noise level was monitored at the output of a narrow-band filter centered at approximately 50,000 cps.

These tests, summarized in Table 1, showed that even with the best selection of circuit and thyratron tube type, there still existed the possibiltiy of an extreme variation in output level of approximately 40 db as a function of tube selection and aging, operating potentials, and ambient temperature fluctuation. As a noise generator for instrument application should have an output level stability of ±1 db under the conditions of these tests, it was clear that a thyratron noise circuit cannot give satisfactory performance without auxiliary circuitry.

Table 1.—Noise levels of circuits shown in Fig. 2.

LOAD	ANODE CURRENT	TUBE TO TUBE db	FILAMENT VOLTAGE db	PLATE VOLTAGE db	TOTAL db	TEMPERATURE EFFECT db	AGING EFFECT db	TOTAL db
CATHODE	5 MA	15.3	8.4	4.0	27.7	3.6	7.5	38.8
	10 MA	18.2	10.0	2.0	30.3	–	–	–
PLATE	5 MA	23.9	8.4	3.0	35.3	–	–	–
	10 MA	17.7	21.0	2.0	40.7	–	–	–

To reduce these variations to the desired level, a delayed-AGC amplifier was developed (Fig. 3). Because the average level of the narrow-band noise level from the 2D21 (approximately 1 volt rms.) precluded a large dynamic range on a following AGC amplifier, it was necessary to attenuate the noise signal approximately 50 db. The attenuated signal, varying from –70 dbv to –30 dbv rms., with noise peaks of about 10-db higher value, permitted the design of an AGC amplifier for distortion-free operation over a wide dynamic range.

Circuit Design Factors

The circuit (Fig. 3) consists of a 2D21 noise generator followed by an amplifier whose gain is controlled by an AGC signal derived from a 6AL5 rectifier. A cathode follower provides a low-impedance output.

The basic circuit of the AGC amplifier was designed around the "flatness-factor" concept described by Mr. A. W. Nolle in the *Proceedings of the IRE*, July, 1948. The flatness factor (M) is the ratio of the change in db input level to change in db output level:

$$M = 1 + (K_1)(K_2)$$

where K_1 is the increase in volts of d-c. bias arising in the rectifier circuit for each increase of 1 db in the a-c. amplifier output, and K_2 is the gain reduction of the controlled stages, in db per volt of d-c. bias developed. Variations arising in the 2D21 circuit indicated that a flatness factor of 40 would have to be designed into the amplifier circuit.

The layout of the amplifier itself was determined primarily by four factors: (1) the necessity for a symmetrical noise-signal output (one in which both the positive and the negative portions of the cycle were retained); (2) the assumption that the peaks were 10 db above the rms. value of the noise level; (3) the bias ranges of the tubes to which the AGC bias would be fed; and (4) the slope of the transconductance curves, which controls K_2 of the equation.

Tests proved that the 6AU6 tube test met these requirements, provided the gain of each stage was held below its maximum value. In the first two stages, the gain was controlled through the use of a 2200-ohm and 15,000-ohm plate-load resistor, respectively, with the cathode connected directly to ground so that the only bias developed on them would be the negative voltage supplied from the rectifier circuit. A 33,000-ohm plate-load resistor and a cathode bias of approximately –1.3 volts was incorporated into the third stage to give a gain of approximately 20 db with a symmetrical signal-noise output.

This layout produced a transconductance curve with a slope (K_2) of 8.5 db per volt of bias. Since an M of 40 was to be realized, the circuit had to be designed to effect a K_1 of, roughly, –4.5 volts per db. A voltage-doubler rectifier circuit using two halves of a 6AL5 tube and a time constant of approximately two seconds in the rectifier circuit was designed to satisfy this requirement. Tests of this circuit, however, showed that the desired M-factor was not realized because the screen potential provided to the two controlled stages by the voltage-divider resistances was not constant for all levels of bias to be used. To correct this deficiency, a VR150 tube was substituted to supply the screen grid potential for these two stages.

In tests in which the line voltage (115-v., 60-cps.) was varied by ±10 percent, the rms. value of the noise signal output of this generator held constant within ±0.5 db, and no deviations greater than ±1-db rms. were observed when a number of different thyratrons were tried in the circuit.

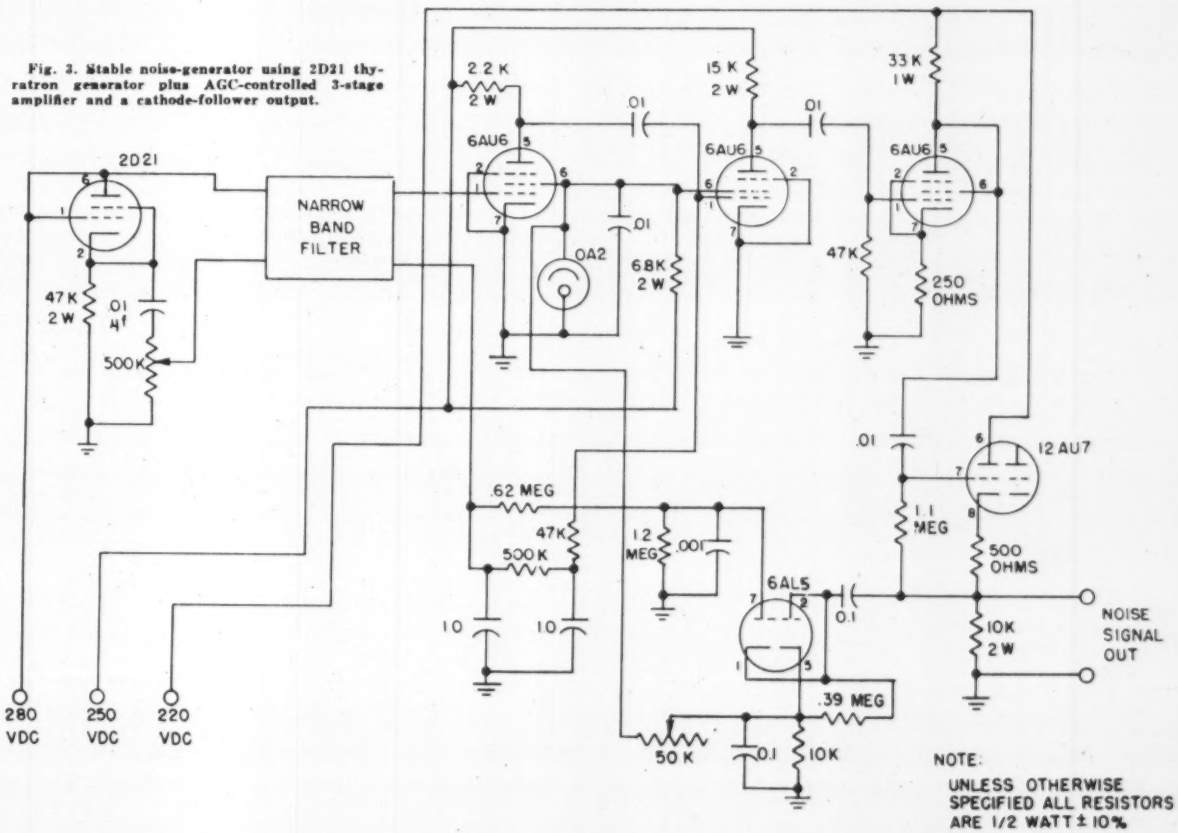


Fig. 3. Stable noise-generator using 2D21 thyratron generator plus AGC-controlled 3-stage amplifier and a cathode-follower output.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

President: *Glen C. Wilson*
Vice-President: *Glen G. Gallagher*
Secretary-Treasurer: *Geo. H. Forster, Jr.*, 640 Fillmore St., Fillmore, Calif.
Auditor: *Norman Jaffe*
Past Pres.: *James A. Serey, Jr.*

Instrumentation of Underground

GAS RESERVOIRS

Underground storage of gas requires accurate metering of gas into and out of the field facilities. This résumé presents the development of the La Goleta field and discusses metering facilities, pressure-regulation technique, transmission lines, moisture and pulsation problems, auxiliary measurements, and accuracy achieved.

RAYMOND W. TODD

Pacific Lighting Gas Supply Co.

Most underground gas-storage projects operate with a considerable volume of gas continually held in the reservoir. This volume is referred to as "base volume gas" or "backlog gas." Errors in measurement of gas being delivered into or withdrawn from gas reservoirs would materially affect this volume and, unless check meters are available or accurate pressure-volume records of the reservoir performance are maintained, such errors might not be detected until serious accumulated differences have occurred.

In order to appreciate some of the measurement and regulation problems, consider one of the first major gas-storage projects in the United States.

La Goleta Field

La Goleta underground storage field is eight miles west of the City of Santa Barbara on the California coastline about 105 miles northwest of the City of Los Angeles. The field was discovered originally by General Petroleum Corporation in August, 1929, when a well being drilled by that company on the More Ranch property in exploration for oil blew out from a depth of 4533 ft. When brought under control the shut-in wellhead pressure was 1700 psi. A second well, More #2, was started in October, 1929, and blew out when the gas sand was encountered. It sanded up and was redrilled to completion in the gas sand. More #3, also drilled by General Petroleum in search for oil, was started in August, 1930, and completed as a gas well.

In 1933 the Standard Oil Company of California drilled two wells on the adjoining Chase Bryce property. One well was completed as a gas producer; the other was outside of the field limits.

Shell Oil Company, in 1934, drilled to a depth of 6508 feet in the search for oil in its Bishop #1. No oil was found; the well was plugged back and completed in the gas sand, which was found to be 305-feet thick at this location.

Thus, after five years of exploration, oil had not been discovered; however, five gas wells had been completed and the operators had turned to the sale of natural gas.

The first gas deliveries were made from the field in 1931, and from then until the Fall of 1941 a total of 15.3 billion cubic feet of gas was produced in the field, which resulted in the wellhead pressure dropping to 1440 psi. This gas was used by the utility companies in Southern California.

During this period of gas production, field records showed that the gas produced per pound decrease in reservoir pressure was steadily increasing, indicating water encroachment was occurring in the field. (Water encroachment keeps pressure from falling.) This, together with an increasing demand for peak load gas, resulted in two conclusions—(1) that the dry gas reserves in La Goleta field would soon be depleted and (2) if the use of the reservoir for storage operations was delayed until the major portion of the gas had been produced, the encroachment of edgewater would by that time be so extensive that the use of the reservoir for gas storage would be impractical. Therefore, in the summer of 1939 arrangements were made for

December Meeting: Thursday, the 16th, Rio Hondo Country Club, Downey, Calif.

Feature: Past Presidents' Night and a movie entitled "Spindletop"—deals with discovery of oil at Spindletop Field, Texas.

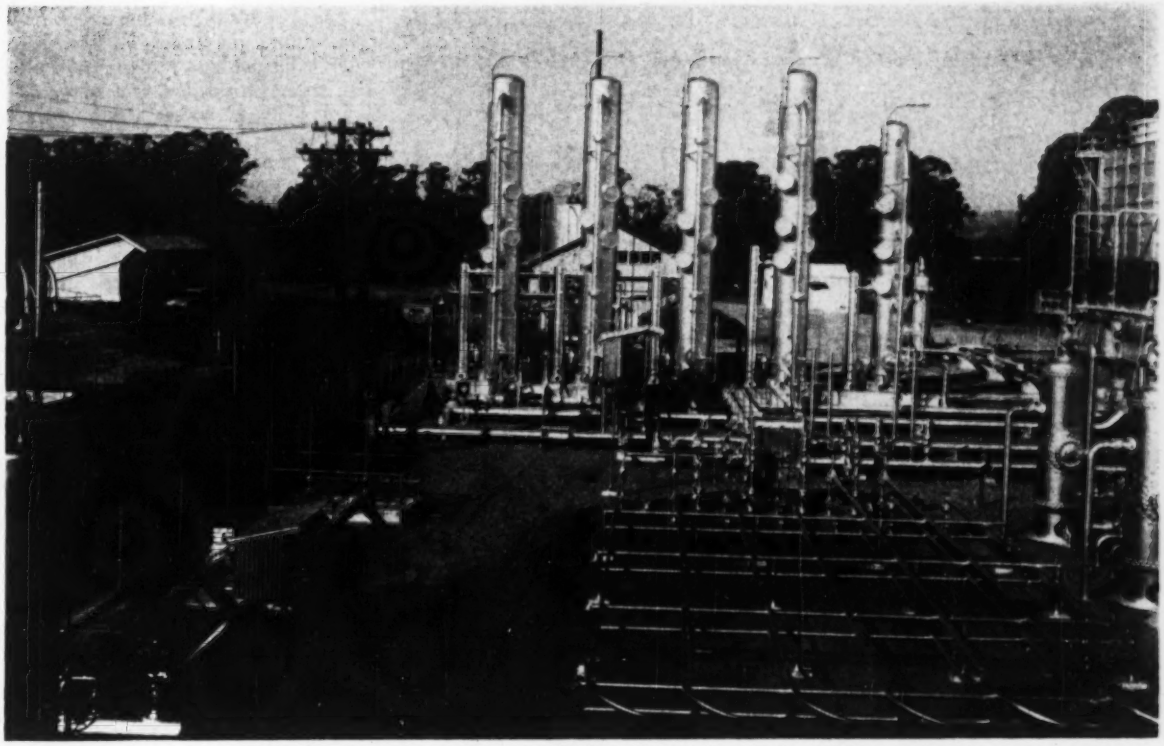


Fig. 1. Diethylene-glycol gas-dehydration plant with capacity of 250 M²cf. per day. Master metering facilities are shown in the foreground.

tests to determine if La Goleta could be utilized for the storage of natural gas.

A small compressor station was constructed and several hundred million cubic feet of gas were injected in the field. These tests showed that the reservoir sand had sufficient permeability to allow the injection of gas and that a satisfactory pressure-volume relationship existed. Therefore, negotiations were inaugurated for the purchase of the surface and mineral rights in the proposed storage zone.

From data compiled during the production of gas prior to storage operations, and from the reservoir pressure-volume relationship during the early stages of storage operations, the volume of the gas in the reservoir at the start of storage operations in 1941 was calculated to be almost 38 billion cubic feet. Adding the 15.3 billion cubic feet of gas produced prior to the start of storage operations, the estimate for the original reservoir content is 53.3 billion cubic feet of gas.

Field Facilities

Soon after the discovery of La Goleta field in 1931, a 16-inch transmission line was installed to deliver the gas from the field to the Los Angeles area. By early 1941, installation of a permanent compressor station had been completed. This station operated with an intake pressure of 300 psi. and could inject 28 M²cf. (million cubic feet) per day at maximum discharge pressure.

The compressor station, field pipeline facilities, field meters, and the injection and withdrawal wells drilled by the Company were designed to operate at a maximum pressure of 2500 psi., in accordance with Division 1, Section 2, Gas and Air Piping of the ASA Code for Pressure Piping. This pressure was approximately 600 psi. more than the maximum pressure necessary to inject the gas into the reservoir at the original static reservoir pressure. It was contemplated when these facilities were installed that, ultimately, gas might be stored at a pressure in excess of the original reservoir pressure; facilities were designed accordingly. The wellheads, valves, flow beans, meters, and other equipment were replaced with equipment for 2500 psi. service. (A flow bean is a manually operated rising-stem control valve with stem position indicated in 64th's of an inch.)

Performance of the field during injection and withdrawal in 1941, 42, and 43 verified the conclusions drawn from the tests of 1939. With the continued rise in demand for peak gas in the Southern California area, facilities were installed to increase the withdrawal capacity of the field to 180 M²cf. per day, and to increase the injection capacity to approximately 70 M²cf. per day. An additional 1800 horsepower was installed in the injection plant, and two wells were drilled. These facilities were completed in 1945. It was necessary to install a 16-inch transmission pipeline between Goleta and Ventura.

Up to the time of the installation of these additional facilities the withdrawal gas was cooled by expanding from well pressure to 450 psi. to remove condensates from the gas picked up during storage. Accurate control had to be maintained on this system in order to eliminate possible formation of hydrates during the cooling phase. The gas then had to be recompressed at Ventura for delivery to Los Angeles. To eliminate this compression the new facilities were designed to operate with an initial pressure at Goleta of 1000 psi. This increased delivery pressure precluded the partial dehydration of gas through expansion cooling and, therefore, a diethylene-glycol dehydration plant was installed. This plant had a capacity of 200 M²cf. per day and was operated at 1050 psi.

Facilities were added; at present the injection plant has a total of 3750

Fig. 2. Metering installation at a well. Meter fittings, meters, and meter lines are enclosed in the house.

horsepower, which permits it to inject gas at the rate of 105 M²cf. per day with an intake pressure of 950 psi. The withdrawal facilities have a capacity of 460 M²cf. per day.

As the maximum withdrawal of gas from Goleta would furnish approximately one-third of the total volume of gas consumed in the Southern California area during peak loads, all precautions must be taken to eliminate any possible loss of this supply of peak gas. As a precautionary measure, two completely independent withdrawal systems which deliver into separate transmission pipelines have been installed. Also, two separate gas dehydration plants have been constructed, one with a capacity of 250 M²cf. per day, the second with a capacity of 210 M²cf. per day. Gas is delivered from the field pipelines to regulator setups located at the dehydration plants, thence through the dehydrators, and metered through master meters into the transmission pipelines. Fig. 1 shows the 250-M² diethylene-glycol plant, with master metering facilities in the foreground.

Metering Facilities

Metering facilities installed by the oil companies for the sale of gas (before the start of storage operations) were installed at one central metering station. This arrangement had not proved satisfactory because considerable operating time was consumed during production in adjusting volumes from each individual well. As new wells were drilled by our company to increase the injection and withdrawal capacity of the field, two-way meters were installed at each well to overcome this difficulty.

The master meters measuring gas to and from the transmission lines consist of one 8-inch, two 10-inch, and one 12-inch orifice meters. "Series 600" orifice fittings are used. The meter tubes are equipped with straightening vanes at both ends, and with meter connections for flow in both directions. Meter readings are recorded by instruments with 1200-psi. springs and 100-inch bowls. During injection, gas is measured to the field through the master meters through reverse flow connections, bypassed around the dehydration plants, compressed, delivered into the field by reverse flow through the field pipeline systems, thence measured through the individual well meters and injected into the wells.

The field meters for measuring gas in and out of the individual wells are either 6-inch or 8-inch "Series 1500" meter runs and fittings with 3000-psi. springs and 100-inch bowls, and can measure flow in both directions. Flange connections are used on the field meters as the thickness of the "Series 1500" flanges makes it impossible to place the 2½-diameter pipe tap in the tube, therefore requiring the use of flange connections. To eliminate the possibility of the serious blow of gas from an individual well during periods of injection (in event of a break in a field line), check valves are installed at each field meter installation with bypasses around the check valve for use during periods of withdrawal.

Meter House

Fig. 2 shows a typical meter setup at the wells. The meter fittings, meters, and meter lines are in the house. These houses have been found necessary because of hydrates in connecting lines freezing during withdrawal. Originally this problem was solved partially by heating the lines with soil heating cable and installing insulation around the cable and meter lines. Although this solution proved effective it did present certain maintenance problems and made it difficult to work on the meters. The meters are now installed so that the connecting lines are as near vertical and as short as possible to prevent accumulation of liquids.

The withdrawal gas has an average temperature of 140 deg. F., which provides sufficient heat (from radiation of the meter fitting and that portion of tubes enclosed within the house) to maintain an ambient temperature high enough to prevent hydrate formation in the metering equipment. The meter houses are constructed of either corrugated asbestos or asbestos shingles, which provides adequate insulating qualities. Atmospheric temperatures at La Goleta seldom drop below 25 deg. F. The house also provides excellent conditions for calibration of meters, changing of meter plates, and other meter work, regardless of weather.

The master metering equipment connecting to the transmission lines has not been housed because the gas delivered to the plant for injection, and that delivered into the transmission lines during withdrawal, has all been dehydrated, thereby eliminating any possible freezing of the meter lines or facilities.

Pressure Regulation

Each well is equipped with flow beans which are used to equalize the flow of gas to and from the wells during periods of injection and withdrawal respectively. During withdrawal only sufficient pressure drop is taken through the flow bean for adjustment of individual well volumes; the gas is delivered to the main regulating station at full field pressure less well and field line drop. The pressure of the gas delivery from the field piping system ranges from 1860 to 1475 psi., depending on the amount of gas in storage and the rate of withdrawal. The gas must be regulated from these pressures down to a pipline delivery pressure of 1000 psi.

Regulation equipment at the #1 station (which has a capacity of 250 M²cf. per day) is accomplished through one 4-inch and two 3-inch "Series 1500" regulators. Regulation at the other station is accomplished with two 4-inch "Series 1500" regulators. Both regulator installations are equipped with an emergency bypass with a 3-inch "Series 1500" variable flow bean as an emergency bypass for the regulators in event of regulator difficulty during peak withdrawal periods. Fig. 3 shows the 3-inch and 4-inch regulators, and the 3-inch flow bean. The angle piping between the regulators and valves has been found necessary as the ring joint gaskets would otherwise necessitate cutting the piping to remove the regulators.

Different size regulators are used in order to accomplish satisfactory regulation for the large variation in flow which occurs. Experience has shown that the 3-inch regulators op-

erate best in a range from 30 to 60 M²cf. per day, whereas the 4-inch regulators operate best within the range of 50 to 100 M²cf. per day. Following regulation, the gas is cooled prior to passing through the dehydration equipment.

Gas Wells

Fourteen wells have been drilled in the field, eleven of which are currently used for the injection and withdrawal of gas. Bishop #1, one of the original five wells drilled in the field, is now used as a control well for observation of pressures during the injection and withdrawal periods.

In contrast to the five original wells in the field (drilled in the search for oil and later converted to the production of gas) the nine wells subsequently drilled by the Company were designed, drilled, and completed for gas.

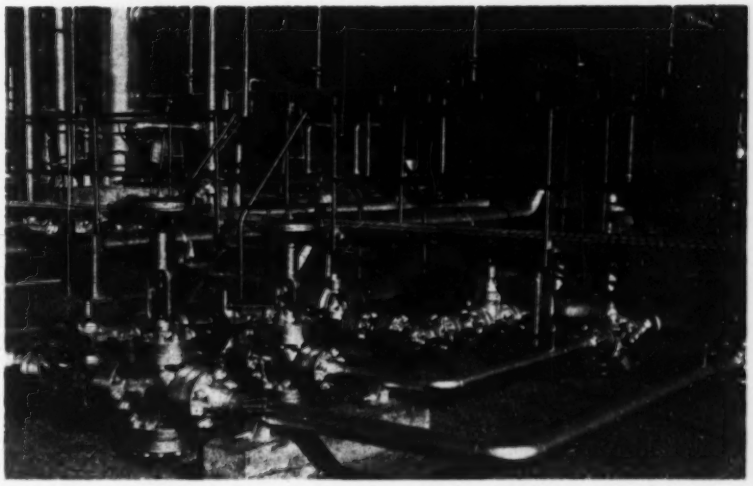


Fig. 3. Three-inch and 4-inch pressure regulators and 3-inch flow bean as emergency bypass.

Transmission Lines

The principal transmission facilities between La Goleta field and the Los Angeles area now consist of a 16-inch, a 20-inch, and a 22-inch pipeline which operate with an initial pressure of 1000 psi. and a capacity of 385 M²cf. per day. These facilities are owned by the Southern California and Southern Counties Gas Companies.

To eliminate high pressure-differentials in the reservoir, the flow of gas is regulated to and from the different wells in the field. Wells completed in the highly permeable sands are assigned higher injection and withdrawal rates than are the wells completed in the sands of lower permeability.

During maximum rates of injection there is from 50- to 60-psi. drop in the field piping system between the discharge of the compressor station and the wellhead, and approximately 60-psi. pressure drop between the wellhead pressure during injection and the shut-in pressure. During periods of withdrawal at rates between 35 and 40 M²cf. per well, the wellhead pressure drawdown is approximately 180 psi.

Metering

Orifice meter plates in all field meters and master meters are inspected monthly. Orifice meters are calibrated monthly. A constant check is maintained between the accumulated total volumes of the field meters and the volumes recorded on the master meters. If any discrepancies are detected an immediate check of the meters is made to locate the difficulty. It has been found that in measuring the large volumes of gas with extreme variations in volume during a 24-hour period, the meter clocks must be maintained in accurate condition, and the orifice meter charts must be set accurately on time.

Gas in storage picks up a small amount of moisture and liquid hydrocarbons. During periods of withdrawal these liquids drop out in field traps or are removed in the dehydration facilities. An accurate record is maintained of the amounts of these liquids so that the volumes measured at the field meters can be corrected for the equivalent volume of liquid which is removed prior to measurement through the master meter. Owing to the large volumes of gas measured through the individual meters and the high variations in temperature, gravity and pressure within a 24-hour period, continuous recorded records of all factors are maintained. It has been found necessary at times to use two or three different coefficients for a meter during one 24-hour period.

Pulsation

At the start of injection operations, pulsation created by the gas compressors seriously affected the measurement of the gas from the transmission lines through the master meters to the compressor units. The measurement at the field meters located at the wells (some of which were approximately three-fifths of a mile from the compressor station) were also affected, but to a lesser degree. To overcome this pulsation problem, and to eliminate serious vibration which occurred in the compressor plant and field piping, the downstream valves on the intake meters were pinched to incur a pressure drop of some 8 to 15 psi.

In view of the horsepower wasted in such an operation, pulsation dampeners have been installed in both the intake and discharge piping to the compressor units. This has eliminated all meter pulsation and has resulted in a saving in compressor horsepower.

Conclusion

A comparison of volumes measured in and out of the field during the last four years (with the volumes measured in and out through the master metering stations after all allowances have been made for liquids, etc.) shows that over a four-year period, during withdrawal of gas, the field meters have measured an accumulated total of 0.97 percent lower volume of gas than the master meters; in the same period during storage of gas the well meters have measured an accumulated total of 0.46 percent less gas than the master meters.

The transmission lines which deliver the gas to and from Goleta for storage and withdrawal have meters located at Ventura in the Southern Counties Gas Company's plant. A check of these meters at Ventura against the master meters located at the Goleta field show that for the same four-year period the total volume of gas measured both for storage and withdrawal has been 0.26 percent lower in volume.

Total volume delivered to the field for injection during this four-year period was 45,605 M²cf., while during the same period 44,514 M²cf. were withdrawn from the field. These figures show that measurement practices at Goleta have resulted in measurement as accurate as can be expected.

The measurement of withdrawal gas at Ventura is made at an average pressure of approximately 300 psi. less than the measurement at Goleta. This shows that present-day measurement equations for measuring at 1900, 1000, and 700 psi. do not result in any major differences.

Test Your I. Q.

Instruments and AUTOMATION

The IQ of an instrument man is very different from that of most people—and, as all instrument men know—much higher. It does not even stand for the same thing—the IQ of an instrument man is his INSTRUMENT QUOTIENT. Now, for the first time, every reader of *Instruments and Automation* can check his own IQ. The answers to every question are to be found in the editorial matter and articles in this issue, and—although this is obviously a waste of space because all our readers will immediately know all the answers—are given on page 1853.

Question 1

Which of the following is an absolute-type vacuum gage that is used to calibrate indirect-type vacuum gages?

(a) McLeod
(b) Knudsen
(c) Pirani
(d) Philips

Question 2

Which of the following vacuum gages has range as low as 10^{-10} mm. Hg?

(a) McLeod
(b) Cold-cathode Philips
(c) Alphatron
(d) Mass spectrometer

Question 3

Which of the following vacuum gages operates on the ionization principle?

(a) Hot filament
(b) Philips
(c) Alphatron
(d) All the above

Question 4

Which of the following vacuum gages operates on heat-conductivity principle?

(a) McLeod
(b) Pirani
(c) Philips
(d) All the above

Question 5

Outgassing of a vacuum system by heating is done in order to eliminate

(a) reaction products
(b) air leakage
(c) vapor pressure
(d) desorbed gases

Question 6

Which of the following statements does NOT apply to the McLeod vacuum gage:

(a) Operates by trapping a known volume of gas and compressing it.
(b) Is the oldest method for accurate vacuum measurements.
(c) Provides continuous reading of pressure in system.
(d) Is the standard for calibrating other vacuum gages.

Question 7

Which of the following vacuum gages would be chosen to measure the molecular concentration (pressure) of a specific component in a high-vacuum system?

(a) Mass spectrometer
(b) Cold-cathode Philips
(c) McLeod
(d) Pirani

Question 8

A chemical trap can be used with a McLeod gage to remove water vapor that could cause erroneous indication of vacuum. The gage plus trap can measure

(a) air pressure only
(b) water vapor pressure only
(c) air pressure and vapor pressure, separately
(d) air pressure plus vapor pressure

Question 9

Metering of gas into an underground reservoir usually is done by

(a) reversing flow through the meters used to measure gas out of reservoir
(b) subtracting gas out of reservoir from measured total reservoir content
(c) measuring reservoir content at end of day
(d) using separate set of meters for gas into and out of reservoir

Question 10

Measurement of total gas content of an underground gas reservoir is made by

(a) filling with known volumes of water before injecting gas
(b) withdrawing all gas into auxiliary reservoirs
(c) estimating from pressure-volume relationships
(d) measuring gas input

Question 11

Water encroachment in an underground gas reservoir is evidenced by

(a) increase in water content of the gas
(b) increase in static pressure of reservoir gas
(c) increase in gas produced per pound decrease in reservoir pressure
(d) all the above

Question 12

In gas metering lines, water and other hydrates often freeze out and plug the meter lines. Techniques to prevent this include:

(a) dehydration of gas
(b) heating lines with soil-heating cable
(c) use of vertical, short meter lines
(d) all the above

Question 13

A flow bean is

(a) a pressure regulating valve
(b) an open flow device, such as a Parshall flume
(c) a straightening vane
(d) a pressure snubber for a flowmeter

Question 14

The unit M'cf. means

(a) one thousand cubic feet
(b) one thousand standard cubic feet
(c) one million cubic feet
(d) one billion cubic feet

Question 15

Measurement of gas volumes into and out of underground reservoirs can be made to an accuracy of about

(a) 0.01 percent
(b) 0.1 percent
(c) 1.0 percent
(d) 10.0 percent

Question 16

The symbol used commonly to represent a differential operator is

(a) jwL
(b) $-j/wC$
(c) p
(d) 1/p

Question 17

The reactance of a capacitor can be expressed as

(a) jwL
(b) $-j/wC$
(c) p
(d) 1/p

Question 18

In perturbation-equation analogs, the slopes of static curves are used to

(a) perform electronic differentiation
(b) perform electronic integration
(c) obtain coefficients for the terms
(d) check the answers

Question 19

Analog computers use electronic integrators rather than electronic differentiators because

(a) integrator circuits are simpler and cheaper
(b) differentiators are less sensitive than integrators
(c) integrators have greater output than differentiators
(d) differentiators have large high-frequency response

Question 20

A disadvantage of potentiometer-type multipliers in analog computers is that the

(a) multiplication factor is less than unity
(b) circuit is more complex than electronic multipliers
(c) maximum multiplication factor is 10
(d) maximum multiplication factor is 100

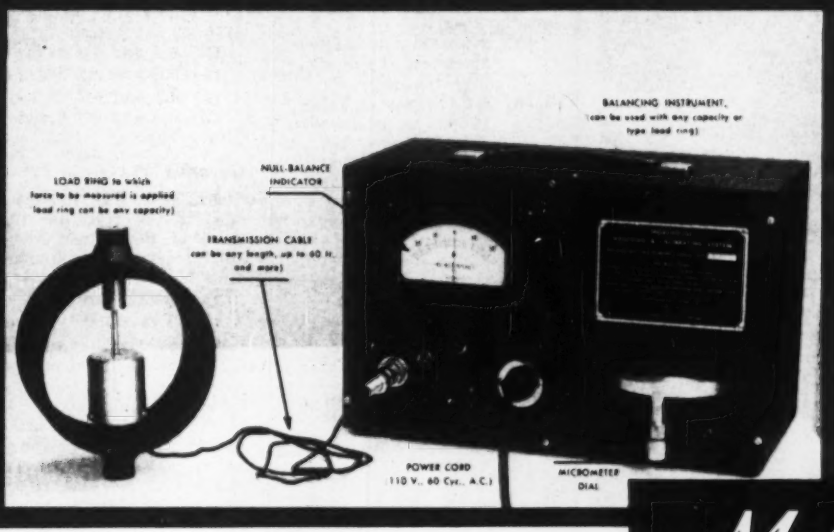
Question 21

Coefficients in equations set up for solution in an analog computer are divided through and made less than unity because the

(a) pot multipliers multiply only by less than unity
(b) sum of all coefficients must be unity
(c) differentiators can not handle larger coefficients
(d) time scale is reduced accordingly

Continued on page 1826

MOREHOUSE WEIGHING AND CALIBRATING SYSTEM


BALANCING INSTRUMENT.
(can be used with any capacity or type load ring)
LOAD RING to which force to be measured is applied (load ring can be any capacity)
NULL-BALANCE INDICATOR
TRANSMISSION CABLE (can be any length, up to 60 ft. and more)
POWER CORD 110 V., 60 Cyc., A.C.
MICROMETER DIAL

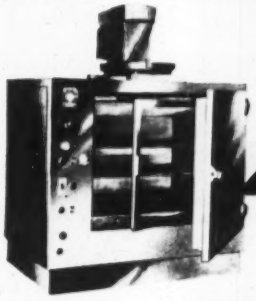
- Accuracy 1/10 of 1%.
- Simplicity of operation allows the most inexperienced operator to obtain results well within 1/10 of 1%.
- Remote indication,—up to 60 ft. and more.
- Sturdily constructed for field or laboratory use.
- Calibrated with dead weights by the National Bureau of Standards.

Send for our latest bulletin, which explains in detail the operation of the Morehouse Weighing and Calibrating system

Morehouse
MACHINE COMPANY
233 W. MARKET ST. YORK, PA.

For more information circle **110** on inquiry card.

NOW! LOWER COST *Controlled* HUMIDITY CABINETS !



BLUE M *Counterflow* **TYPE**

MEETS MOST MIL. & JAN SPECS.

FEATURES

HIGH HUMIDITY WITHOUT CONDENSATION ON TEST SPECIMENS

AUTOMATIC HUMIDITY CONTROL
50 to 99%

DRY BULB TEMPERATURE
Room to 70°C.

- POLISHED STAINLESS STEEL 18-8, inside and out
- POWER SELECTOR SWITCH Adjusts wattage in 3 steps
- INNER GLASS DOOR
- DIRECTED AIR FLOW Vertical pattern
- IMMEDIATE INSTALLATION
- COMPLETE RELIABILITY

MODEL NO.	INSIDE DIMENSIONS W.	D.	H.	COMPLETE PRICE
CF-740H	14"	13"	14"	$ 935.00
CF-770H	37"	19"	25"	$1745.00

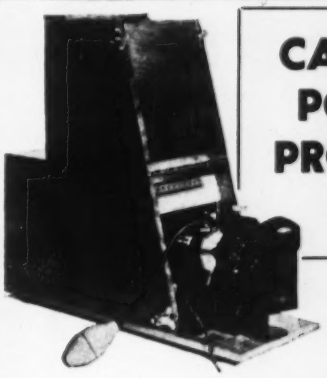
OTHER STANDARD MODELS AVAILABLE

LOW IN COST HIGH IN VALUE

BLUE M ELECTRIC COMPANY
138th and CHATHAM, BLUE ISLAND, ILLINOIS

For more information circle **111** on inquiry card.

CAMBRIDGE PORTABLE PROJECTION VIEWER



This new Projection Viewer, used in conjunction with the Lindemann-Ryerson Electrometer, facilitates observation of the deflection of the electrometer pointer. A beam of light from a lamp in front of the case projects the image of the index pointer onto a mirror in the rear of the case. This image, magnified 100 times, is then reflected upon a translucent screen, clearly visible in the front and upper part of the case. This screen is 120 mm. long and is divided into 120 divisions numbered 60-0-60. The pointer is zeroed by grounding the electrometer by means of a rubber bulb.

3¼" x 2⅜" x 1⅜"
Weight 3½ oz.

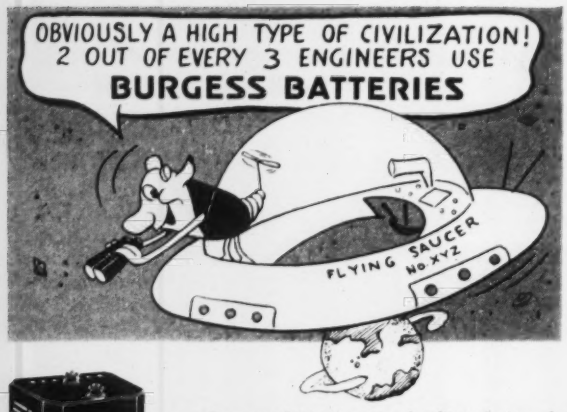
LINDEMANN-RYERSON ELECTROMETER

This instrument is extensively used for the determination of radioactive emission. Has high sensitivity, good stability and does not require leveling.

Send for descriptive literature

CAMBRIDGE INSTRUMENT CO., INC.
3742 Grand Central Terminal, New York 17, N. Y.
Pioneer Manufacturers of Pioneer Instruments

For more information circle **112** on inquiry card.



No. 4FH

No. Z30NX

Burgess Batteries are the first choice of 2 out of 3 electronic engineers, due to their uniform operation and consistently high quality. There's a Burgess Battery to fit every need . . . including the all-new transistor types.

Write for FREE engineering manual listing the complete line of BURGESS BATTERIES and specifications, the FREE check sheet to enter new battery specifications, and the new transistor battery sheet.

BURGESS BATTERIES

BURGESS BATTERY COMPANY FREEPORT, ILLINOIS

For more information circle **113** on inquiry card.

PROTECT

EXPENSIVE GAGES

SPRAGUE SHUT OFF VALVES automatically cut out gages and other pressure-sensitive instruments when fluid pressures go beyond their operating limits. Automatically open when pressure is again within approx. 80% of set cut-out points. Available for any pressure setting between 10 PSI. and 5000 PSI. Save valuable man hours. Eliminate opening and closing manually operated shut off valves. Supplied with standard pipe thread connections, also available with AN tube fittings. Body is 1½" aluminum hexagon stock. Length 5½". Bronze or stainless steel bodies also available. Easy to install. Thousands in use. Write for bulletin.

SPRAGUE

Engineering and Sales Co.

1144 WEST 135TH STREET, GARDENA, CALIFORNIA

For more information circle **114** on inquiry card.

Question 22

A recommended method for specifying orifice plates so that edge thickness will have no effect on discharge coefficient is to specify that

(a) maximum edge thickness be 1/40 pipe diameter
(b) maximum edge thickness be 1/40 beta ratio
(c) correction factors be included for beta ratio
(d) correction factors be included for Reynold's number

Question 23

A scale that has the same percentage accuracy at all points has scale divisions that are

(a) wider at low end
(b) evenly divided
(c) wider at high end
(d) wider at mid-scale

Question 24

An indicating instrument has a 100-division scale and 1-percent full-scale accuracy. At the 10-division point of scale, the error can be

(a) 0.01 division
(b) 0.1 division
(c) 1.0 division
(d) 10.0 divisions

Question 25

In reading scales and estimating to the nearest tenth division, the greatest uncertainty of estimation appears to be in the area of

(a) 0.1 and 0.9 division
(b) 0.2 and 0.6 division
(c) 0.3 and 0.7 division
(d) 0.4 and 0.8 division

Question 26

An electrical indicator sent to the National Bureau of Standards for a conventional standardization test is tested at

(a) 3 cardinal points
(b) 5 cardinal points
(c) 10 cardinal points
(d) all cardinal points

Question 27

The following reasons often are offered to explain why complete automation of factory processes is not accomplished. Which of these four reasons is not justified?

(a) Complexity of production processes
(b) Wrong attitude of manufacturers
(c) Lack of cooperation between materials-handling and ma-

Statement of Ownership, etc.

Statement of the Ownership, Management, Circulation, Required by the Act of Congress of August 24, 1912 as amended by the Acts of March 3, 1933 and July 2, 1946 (Title 39, United States Code, Section 233) of

Instruments and Automation

published monthly at Pontiac, Illinois, for October 1, 1954.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Richard Rimbach, Pittsburgh, Pa.; Editor, M. F. Behar, Pittsburgh, Pa.; Managing Editor, Richard Rimbach, Pittsburgh, Pa.; Business Manager, Richard Rimbach, Pittsburgh, Pa.

2. The owner is: (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one percent or more of the total amount of stock.)

Instruments Publishing Company, Inc., Pittsburgh, Pa.

M. F. Behar, Pittsburgh, Pa.; Jackson Burgess, Freeport, Illinois; M. D. Pugh, Altadena, Calif.; Martha B. Rimbach, Allison Park, Pa.; Richard Rimbach, Pittsburgh, Pa.; Richard J. Rimbach, Jr., Pittsburgh, Pa.; Freda Seibert, Pittsburgh, Pa.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Richard Rimbach, Publisher

Sworn to and subscribed before me this 24th day of September, 1954. Kenneth M. Winterbottom, Notary Public. My commission Expires December 11, 1955.

chine-tool manufacturers
(d) High cost of development of automatic production processes

Question 28
The T-42 Ionization Transducer is basically sensitive to
(a) pressure and temperature
(b) displacement and capacitance
(c) acceleration and conductivity
(d) all the above

Question 29
The Tacitron is a
(a) gas diode
(b) conventional thyratron
(c) low-noise thyratron
(d) tetrode thyratron

Question 30
A chatter accelerometer uses
(a) loose mass on vibrating surface
(b) resonant vibration of clamped bar
(c) shaker table
(d) velocity pickup

Question 31
Laboratory standard electrical indicators have an accuracy of
(a) 0.01 percent
(b) 0.1 percent
(c) 1.0 percent
(d) 10 percent

Question 32
Maximum accuracy that can be realized from electrical indicators is about
(a) 0.01 percent
(b) 0.1 percent
(c) 1.0 percent
(d) 10 percent

Question 33
The function of the 2D21 in Fig. 1 of page 1819 is to
(a) generate noise signals
(b) amplify noise signals
(c) rectify noise signals
(d) filter noise signals

Question 34
The function of the 6AL5 in the same circuit is to
(a) amplify noise signals
(b) filter noise signals
(c) provide output signal at low impedance
(d) control gain of amplifier

Question 35
The function of the 6AU6 stages in the same circuit is to
(a) generate noise signals
(b) amplify noise signals
(c) rectify noise signals
(d) filter noise signals

Announcing——

PROCESS CONTROL

by

A. J. Young

Imperial Chemical Industries, Ltd.

Covers:

control problem
operation of closed-loop
modes of control
& types available

Cloth, 134 + vi, illustrated, 3-page index.

$2.00 postpaid

(Payment must accompany order)

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $..... for..... copies of Young's PROCESS CONTROL BOOK at $2.00 each, postpaid.

Name .....

Address .....

City .....

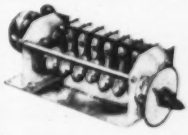
Be sure to see this modern

Zenith AUTOMATIC CONTROL EQUIPMENT

at the New York Show

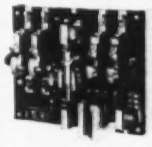
● 1ST INT'L. AUTOMATION EXPOSITION Nov. 28-Dec. 2 . . . BOOTH 418

ZENITH MULTI-CIRCUIT CYCLE TIMERS



Specially designed to accurately time any electrical operation. Set for on and off periods with as many circuits as desired. Furnished with synchronous motor for elevator control, limit switch, etc.

ZENITH AUTOMATIC TRANSFER SWITCHES



Automatic transfer to emergency source in 1/25th second . . . automatic return to normal voltage when restored. Supplied ac. or dc. Capacities up to 400 amps.

ZENITH INTERVAL TIMERS—
MANUALLY PRE-SET

No clock springs to wind or break . . . powerful, self-starting, slow-speed, synchronous motor insures dependable operation. Timing ranges from 60 seconds to 72 hours. 115 and 230 volt models.

ZENITH RESET TIMERS—
AUTOMATIC, REMOTE CONTROL

Easily pre-set, automatically reset. Synchronous motor opens and closes circuits as pre-set. May be used as timer in conjunction with standard start-stop push button station.

ZENITH PROCESS TIMER—
with new PERCENTAGE CALIBRATION

For Hold Fire Control, Mixing Machinery, Testing Equipment, Fans, Heaters, etc. Wide variety of models for all types of adjustable automatic cycle timing. Total time cycle from 15 seconds to 24 hours, with range of adjustability to 94% for ON or OFF periods.

OTHER ZENITH AUTOMATIC CONTROL EQUIPMENT

—switches, contactors, motors, relays, solenoids, etc.—will also be on display. And all are illustrated and described in the valuable Zenith Catalog. Ask for your copy at the Exposition . . . or write direct today.

ZENITH ELECTRIC CO.
159 W. WALTON ST., CHICAGO 10, ILLINOIS

For more information circle **115** on inquiry card.

Only 3 minutes . . .

to the heart of the "second industrial revolution"

THE AUTOMATIC PRODUCTION SHOW

FIRST INTERNATIONAL

AUTOMATION

EXPOSITION

In less time than you take to smoke one cigaret, a subway train can whisk you from the lower lobby of Manhattan's Statler Hotel (site of ASME's annual meeting) to the 244th Regiment Armory, where you'll find in progress the most-talked-about exposition of the new era of automatic production.

Here you will find the latest advances in automatic controls, electronic computers, and allied equipment, designed specifically to enable you to apply automation to your industrial operations.

Please consider this your invitation to attend. Drop in at your convenience. Show hours are 2 to 10 pm. daily, Nov. 29 to Dec. 2, at the Armory on 14th St. between 6th and 7th Aves., New York City.

— NO CHARGE —

Admission by registration only

An Electronic Computer Clinic will also be held at the Armory. in conjunction with the Exposition. Registration fee is $5.00

Use this coupon to expedite your registration forms, and save you time at the Exposition.

First International Automation Exposition,
845 Ridge Avenue, Pittsburgh 12, Pa.

Name ..... **Title** .....

Company .....

Address .....

City ..... **Zone** ..... **State** .....

☐ Send me expedited registration forms for the Automation Exposition. (No registration fee)

☐ Send me information on the First Electronic Computer Clinic.

Events . . .

Instruments and AUTOMATION

November 29—December 2

First International Automation Exposition and Computer Clinic, at the 244th Coast Artillery Armory, New York City, N. Y. For information write First International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

December 5-9

Midyear Meeting of the SAMA laboratory apparatus and optical sections, The Carolina Hotel, Pinehurst, North Carolina. For information contact Jim Irving, SAMA, 20 North Wacker Drive, Chicago 6, Ill.

December 8-10

Eastern Joint Computer Conference and Exhibition will be held at Bellevue-Stratford Hotel, Philadelphia. For information write Computer Conference and Exposition, P.O. Box 7825, Phila. 1, Penna.

January 17-19

Fourth Meeting of Conference on High-Frequency Measurements sponsored by IRE, AIEE, URSI, and NBS, Hotel Statler, Washington, D. C. For information contact F. J. Gaffney, Fairchild Guided Missiles Div., Fairchild Engine & Airplane Corp., Wyandanch, L. I., N. Y.

January 26-28

Symposium on Instrumentation for Process Industries, School of Engineering, Chemical Engineering Dept., Texas A&M College, College Station, Texas. For information write c/o Engineering School, Texas A&M.

January 27-28

Fourth Annual Instrument Short Course at Los Angeles Harbor Junior College, Wilmington, Calif. For information write J. R. Wilson, SCMA, 640 Fillmore St., Fillmore, Calif.

February 28-March 4, 1955

Sixth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, William Penn Hotel, Pittsburgh. For information write J. F. Miller, Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Penna.

May 14-22

Chemical Engineering and Equipment Exhibition at Frankfort, Germany. For information write Dechema, Rheingan-Allee 25, Frankfort/M, Germany.

June 28—July 9

Third British Instrument Industries' Exposition at Earl's Court, London. For information write F. W. Bridges & Sons, Ltd., Grand Bldg., Trafalgar Square, London W. C. 2, England.

June 13-17

Annual Symposium on Molecular Structure and Spectroscopy, Ohio State University. For information write Prof. Harold H. Neilsen, Dept. of Physics, Ohio State University, Columbus 10, Ohio.

OPTICAL QUALITY CONTROL TOOLS

Check, Measure, Inspect with the

Edscorp POCKET COMPARATOR

Linear Dimension
Angles, Radii, Diameters
Stock No. 30,061-AM

$24.50 pstpd

Size 1½"x2" Approx. complete with leather case

Instant direct measurement of small parts, mechanisms, irregular items, soft rubber, stains, deposits, textiles! Linear dimensions in decimal inches and millimeters. Holes to .005" diameter! 6-power magnification. Triplet lens for wide, flat field, accurate to edge. Clear plastic base admits light. Cell anodized metal. Focus adjustment.

Illuminator For Comparator . . Any Make!

Light up the object to be measured. Tiny bulb in ring throws light on object as well as on reticle. Pen light batteries in handle provide current. Use it in dark corners, inside machines, etc. 2 batteries & bulb included.

Stock No. 50,076-AM $7.95 pstpd

DIRECT MEASURING MICROSCOPE

Industrial-type microscope and base with adapter for taking any make pocket comparator. Comparator locks in place with one adjustment, is easily removed for use alone. Provides erect image of object and reticle, no reversal of movements as with ordinary laboratory microscope. Working distance under objective 5½". Rack and pinion focusing, variable tension, lock. Scope swings 360°, bracket allows flexible arrangement. Chrome and gray wrinkle finish.

STOCK NO. 70,049-AM

$75.00 pstpd

SEND FOR CATALOG!

Huge selection of lenses, prisms, war surplus optical instruments, parts and accessories. Telescopes, microscopes, binoculars. Hand spectroscopes, reticles, mirrors, Ronchi rulings, dozens of other hard-to-get optical items. America's No. 1 source of supply for research labs, engineers, scientists, inventors.

Ask for catalog AM

Open account to rated firms or send check or M.O.

WE GUARANTEE SATISFACTION

or money refunded in full

EDMUND SCIENTIFIC CORP., BARRINGTON, N. J.

For more information circle **116** on inquiry card.

200 MILLION count life

STROKE COUNTER

Wear Defying

Stay on the Job Millions of Counts Longer

REVOLUTION COUNTER
Accurate at speeds to 4000 R.P.M.

Complete Catalog mailed on request

Increased dependability. Greater long run accuracy. Reduced upkeep costs. No wonder progressive cost-conscious plants are switching to Silver Kings.

Built rugged as a bulldozer, Silver Kings operate smooth as a watch. Extra heavy shaft, oversize bearings, life tested parts, all-steel housing, chrome plated finish.

Available in Stroke and Revolution types, top-coming or top-going action, 5 or 7 digits, right or left shaft, knob or key reset.

SEE—COMPARE—TEST. Ask your PIC Representative or write.

PRODUCTION INSTRUMENT COMPANY
702 W. Jackson Blvd., Chicago 6, Ill.

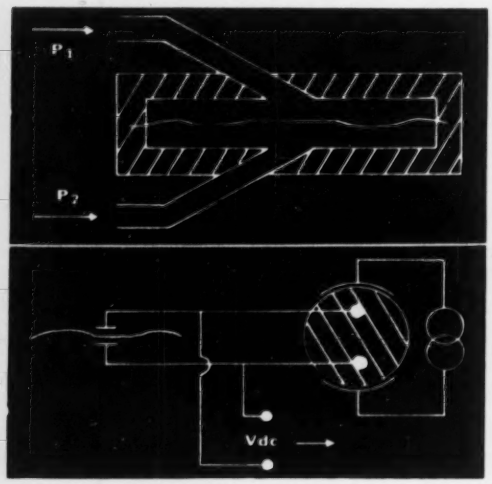
For more information circle **117** on inquiry card.

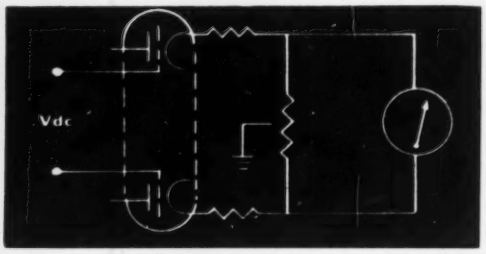
Briefs . . .

Pressure Meter Uses T-42 Ionization Transducer

The pressure differential to be measured is applied to a double pressure chamber having negligible volume and causes a minute movement of a beryllium-copper diaphragm which is used far below the elastic limit. . . . The motion of the diaphragm is converted into an electrical signal by a new and completely unique ionization transducer. The transducer is a sealed envelope, containing noble gases under reduced pressure, which is excited by a small radio frequency oscillator. . . . The transducer output voltage is applied to a cathode follower and the output drives the indicating meter or is available for oscillography. . . . There is no amplifier in the system. The output voltage is 8.5 volts for a pressure differential of 1000 microns Hg. (0.535 inch H_2O). (*From new 2-page Instrument Data Sheet* 303-1, *Decker Aviation Corp.*, 1361 *Frankford Ave., Phila., Pa.*)

For this literature circle **401** on inquiry card.



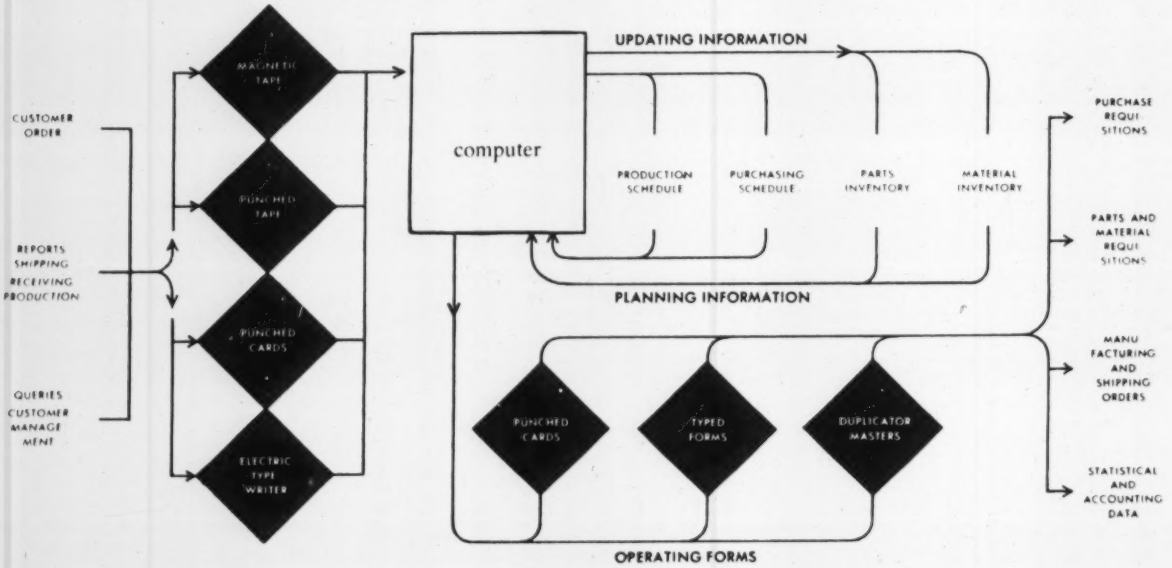


Production Control by Data Processing

Starting with the simplest system, an ElectroData system consists of a digital computer, a control console containing a high-speed photoelectric tape reader and an automatic typewriter for output.

The problem is first broken down into a sequence of simple instructions which specify what the computer is to do. These instructions, in numerical form, are punched into paper tape or cards and subsequently read into the computer's magnetic-drum storage or auxiliary magnetic-tape storage.

The computer performs each instruction automatically in a fraction of a second. For example, it performs 500 additions or subtractions per second, 120 multiplications per sec-



EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, *Industrial & Engineering Chemistry*, Vol. 22, page 596, June 1930.

BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

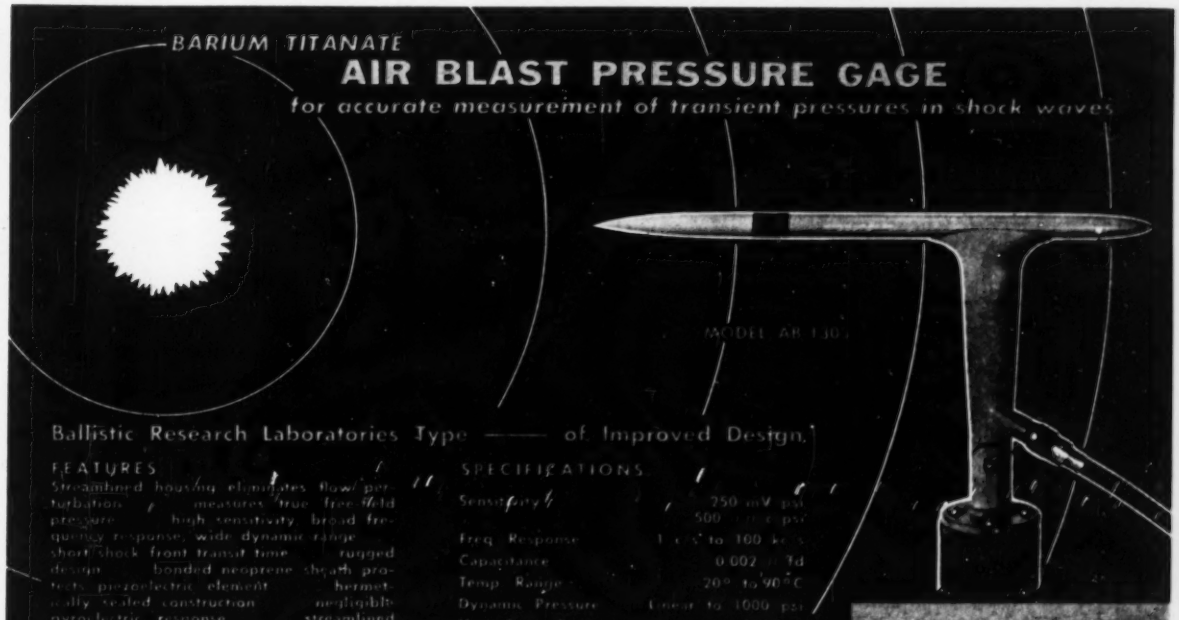
NEWPORT, RHODE ISLAND, U. S. A.

For more information circle **118** on inquiry card.

BARIUM TITANATE

AIR BLAST PRESSURE GAGE

for accurate measurement of transient pressures in shock waves



Ballistic Research Laboratories Type —— of Improved Design

FEATURES

Streamlined housing eliminates flow perturbations ... measures true free-field pressure ... high sensitivity, broad frequency response, wide dynamic range ... short shock front transit time ... rugged design ... bonded neoprene sheath protects piezoelectric element ... hermetically sealed construction ... negligible pyroelectric response ... streamlined strut pivots in vertical and horizontal plane for alignment ... locks in position ... other models available

SPECIFICATIONS

Sensitivity	250 mV psi
	500 [illegible] psi
Freq. Response	1 c/s to 100 kc/s
Capacitance	0.002 μfd
Temp. Range	20° to 90°C
Dynamic Pressure	Linear to 1000 psi
Max. Static Pressure	500 psi
Weight	14 oz
Dimensions	5 8"D x 14"L x 8"H

Chesapeake

INSTRUMENT CORPORATION

SHADY SIDE, MARYLAND

TRANSDUCERS · ACCELEROMETERS · GEOPHONES · PRESSURE PICKUPS · SONAR DEVICES

For more information circle **119** on inquiry card.

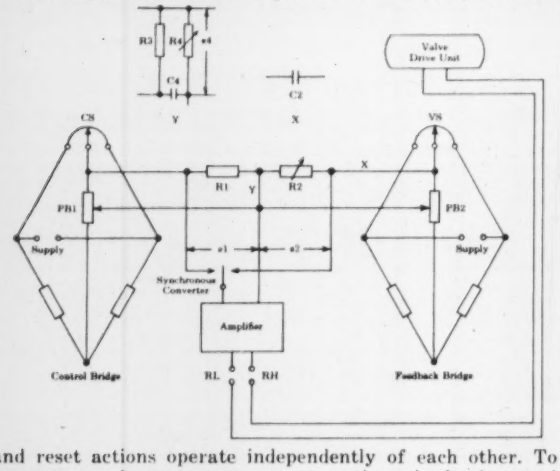
ond, and 85 divisions per second. It compares numbers or other results by command, and automatically makes decisions which may change its subsequent operation.

Answers to the problems, in the form of numbers, reports, checks, parts lists, etc., are automatically typed out, punched out on paper tape or cards, or printed out on a tabulator. (*From new 20-page brochure, EDC-3200, Electrodata Corp., 717 N. Lake Ave., Pasadena 6, Calif.*)

For this literature circle **402** on inquiry card.

New 3-mode Electric Controller

The introduction of Series 60 control makes available a complete electric control system that gives even better performance than our Series 50. Of completely new design, Series 60 provides a more responsive control action . . . rate



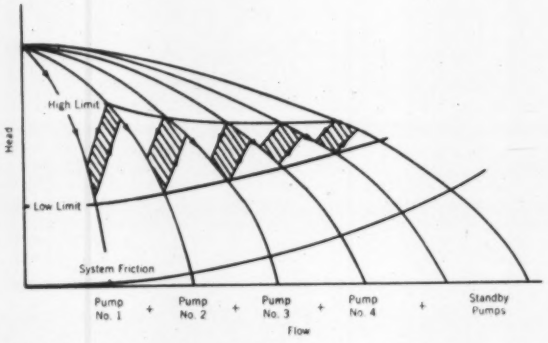
and reset actions operate independently of each other. To prevent overshoot at start-up, automatic cutback of control action prior to reaching the control point is a standard feature.

The circuit consists essentially of two Wheatstone bridges connected through a series of resistors and capacitors to a detecting amplifier. By means of these simple electric elements, the unit provides *proportional, reset* and *rate action.* How the circuit provides these three actions is explained below. (*From new 16-page Folder ND 4 (7), Leeds & Northrup, 4907 Stenton Ave., Phila. 44, Pa.*)

For this literature circle **403** on inquiry card.

Water Distribution Control

The two fundamental factors in any water distribution system are flow and pressure. . . . There is more to the selection of a pump than merely consideration of capacity, head, and efficiency. . . . From the standpoint of surge and fluctuation, the closed system is probably the most stable system of water distribution.



The characteristic curve is important to any system. . . . Figure 6 shows composite characteristic curves for a group of pumps (for a closed system). As the demand steps up, the flow increases and the pressure drops to the intersection of the low limit line. At that point, the control transfers and introduces a second pump. (*From new 16-page reprint of article by J. S. Williams, Automatic Control Co., 995 University Ave., St. Paul 4, Minn.*)

For this literature circle **404** on inquiry card.

New-principle DC Amplifier

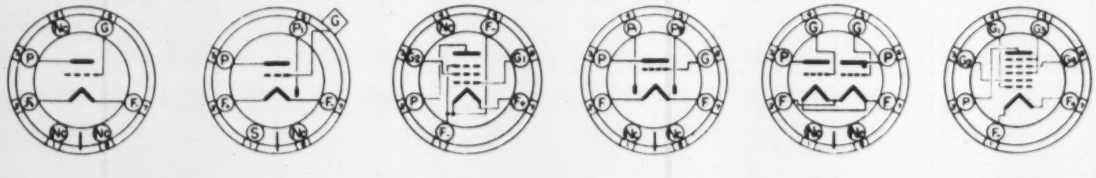
The Fielden D.C. Amplifier is a simple null balance amplifier which provides an output current proportional to input current or voltage. The unbalance detector consists of a D'Arsonval meter movement in which the usual pointer is replaced by a vane. Any unbalance between the electrical input signal and output current will cause the meter element to move this vane up or down scale in relation to a second fixed vane. The change in capacitance between the vanes changes the level of oscillation in an oscillator circuit which in turn changes the output current to return the system to balance. . . . The feedback functions to provide a high dynamic input impedance in the case of millivoltage inputs, and a low dynamic input impedance in the

Tube Manual

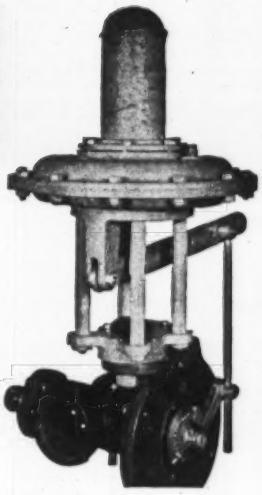
(*From new 200-page "Tung-Sol Tube Characteristics Manual," containing data on 600 receiving tubes, 100 premium types, 170 CR types, 85 diodes, and codes, Tung-Sol Electric Inc., Newark 4, N. J.*)

For this literature circle **405** on inquiry card.

		FILAMENT			TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS											BULB		BASE	
TYPE	DESCRIPTION	VOLTS	AMPERES	TYPE OF CATHODE	APPLICATION	PLATE VOLTS	SCREEN GRID VOLTS	CONTROL GRID VOLTS (BIAS)	PLATE CURRENT MA	SCREEN CURRENT MA	TRANS-CONDUCTANCE μMHOS	PLATE RESISTANCE MEGOHMS	AMPLIFICATION FACTOR	LOAD RESISTANCE OHMS	POWER OUTPUT WATTS	RECTIFIER CONDENSER INPUT: MAX. A.C. PER PLATE VOLTS RMS	RECTIFIER CONDENSER INPUT: MAX. PEAK INV. VOLTS	RECTIFIER CONDENSER INPUT: MAX. D.C. OUTPUT MA.	STYLE	DRAWING NO.	STYLE	RETMA NO.
1G6GT	DOUBLE TRIODE	1.4	0.1	FIL.	CLASS B AMPLIFIER	90		0	2*	Current for both sections			12 000	0.35	Load is Plate-to-Plate			T-9	29	8 PIN OCTAL	7AB	**1G6GT**
1H4G	TRIODE	2	0.06	FIL.	CLASS A AMPLIFIER	180		13.5	3.1		900	10.3	9.3					ST-12	46	7 PIN OCTAL	5S	**1H4G**
1H5G	DIODE TRIODE	1.4	0.05	FIL.	CLASS A AMPLIFIER	SAME CHARACTERISTICS AS TYPE 1H5GT												T-9	43	7 PIN OCTAL	5Z*	**1H5G**
1H5GT	DIODE TRIODE	1.4	0.05	FIL.	CLASS A AMPLIFIER	90 67.5		0 0	0.15 0.06		275 210	240 300	65 60					T-9	28	7 PIN OCTAL	5Z	**1H5GT**



Cure for 3 Headaches!



1. Installation Problems
2. Fitting Costs
3. Engineering Time

CONOMOTOR
Pneumatic Diaphragm Motors for Operating BURNER VALVES

Available from stock. Assembled complete with any valve; North American, Hauck, Maxim-Premix, wafer-type butterfly, etc. All ovens, furnaces, kilns can be efficiently controlled by ConoMotor pneumatic diaphragm motors. Let us ship your burner valve assemblies complete with brackets, levers, etc. ready to mount and operate. Eliminate headaches . . . write for BULLETIN B1020 while you're thinking of it.

CONOFLOW CORPORATION
2100 ARCH ST.
PHILADELPHIA 3, PA.

CC 112

Cono-Controls

For more information circle **120** on inquiry card.

Specify THE BEST

• PHILADELPHIA

THERMAL CONTROLS AND THERMOMETERS

Our Leadership for nearly a half century is your assurance of complete satisfaction when you specify a "Philadelphia" instrument.

Steady, accurate and dependable performance is guaranteed.

PHILADELPHIA THERMOMETER CO.
4400 N. Sixth St. • Philadelphia 40, Pa.

Feel free to consult with our specialized staff on any problem in our field.

SEND FOR CATALOG 110A

For more information circle **121** on inquiry card.

Precision Laboratory Measurement of
- Small quantities of gas or air flow
- Replacement for sight feed bubblers

DWYER SERIES 490 FLOWMETER

Accuracy—Readings are on-the-line—not approximations.

Easy to read—Light enters from all sides of the solid acrylic transparent body for easy reading. Tapered indicating tube precision drilled, reamed and polished.

Control Valve—Built-in.

Scales—Standard 0-2, 0-4 or 0-10 CFH. Air, 0-100 CC/Min. Water. Special ranges available in production quantities.

Models—Single or multiple units, surface mounting type.

Mounting Holes—To specification.

Fittings—⅛ SPT connections provided.

Dimensions—4" high x 1" square.

Ask for complete information.

DWYER *Specialized* INSTRUMENTS and GAGES

F. W. DWYER MFG. CO. • 305 SO. WESTERN AVE. • CHICAGO 12, ILLINOIS

For more information circle **122** on inquiry card.

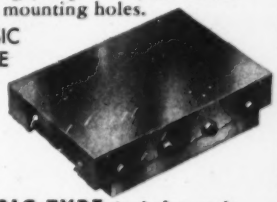
GILMAN *Standard* SLIDE ASSEMBLIES ....

ASSEMBLED TYPE

...SPEED BUILDING OF *Special* MACHINES

ASSEMBLED TYPE includes male and female members, gib and adjusting screws, return springs, stop screw, end shield and mounting holes.

BASIC TYPE



BASIC TYPE includes male and female members, gib and adjusting screws.

Reduce designing and manufacturing time on your *special* production machines with these *standard* slide assemblies. Ample stocks assure good delivery.

- Available with sliding surfaces either *machined* or *hand scraped*.
- 52 types and sizes. *Widths* from 2" to 6"; *lengths* from 3" to 16"; *travel* from ¼" to 4".

VISIT US AT BOOTH 205 —AUTOMATION SHOW

Write Now for FREE Literature

RUSSELL T. GILMAN, Inc.
2415 N. FARWELL AVE. • MILWAUKEE 11, WIS.

For more information circle **123** on inquiry card.

CONVERT MOTION TO ELECTRICAL ENERGY WITHOUT CONTACT

Designed for small space and light weight applications.

Produces Variable AC Electrical Output.

Engineers in All Principal Cities

Controls electrically operated devices . . . rockets . . . guided missiles . . . etc. For mechanical or electrical counting . . indicates rate of travel, angular or linear speed . . . vibration.

Model 3015 generates electrical energy in proportion to any magnetic object's rate of speed. No mechanical contact with exciting metal necessary. Self-energized by built-in permanent magnet. Ruggedly constructed to withstand severe shock and vibration. Weighs only ⅓ ounce.

Write for New Technical Bulletin and Applications Today!

Electro ELECTRONIC EQUIPMENT

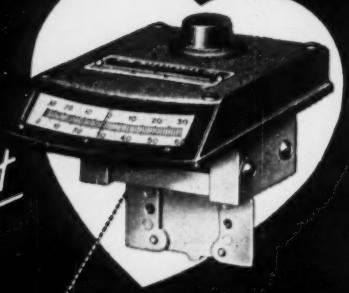
ELECTRO PRODUCTS LABORATORIES
4501-Ix N. Ravenswood Ave.
Chicago 40, Ill.
Canada: **Atlas Radio Corp., Ltd., Toronto**

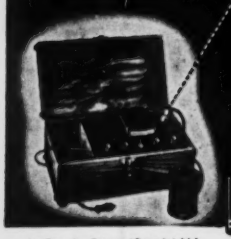
For more information circle **124** on inquiry card.

Make a GM **PORTABLE D'ARSONVAL**

GALVANOMETER

the Heart of Your Instrument





FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

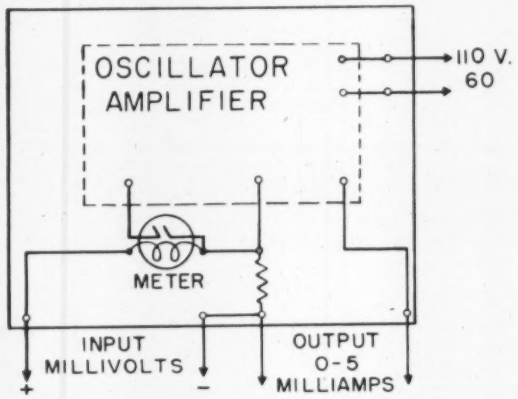
GM LABORATORIES, Inc.

In Canada: Cossor (Canada) Ltd., 301 Windsor St., Halifax, N. S.

4316 NORTH KNOX AVE., CHICAGO 41

For more information circle **125** on inquiry card.

BRIEFS—CONTINUED



case of microampere inputs. . . . The amplifier is practically independent of resistance in the output circuit because feedback is determined by the output current and this tends to maintain this current independent of circuit resistance. (*From new 2-page Bulletin F-801, Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4 St., Phila. 33, Pa.*)

For this literature circle **406** on inquiry card.

New-concept Variable-area Flowmeter

The MODEL 1-100 Primary Flow Measurement Element combines orifice simplicity and economy with variable area

AGASTAT

Compact . . . Dust-Proof
TIME DELAY RELAYS
solenoid actuated—pneumatically timed

Introduces time delays into a-c or d-c circuits. Easily adjusted to provide delays ranging from 0.1 second to five or more minutes.

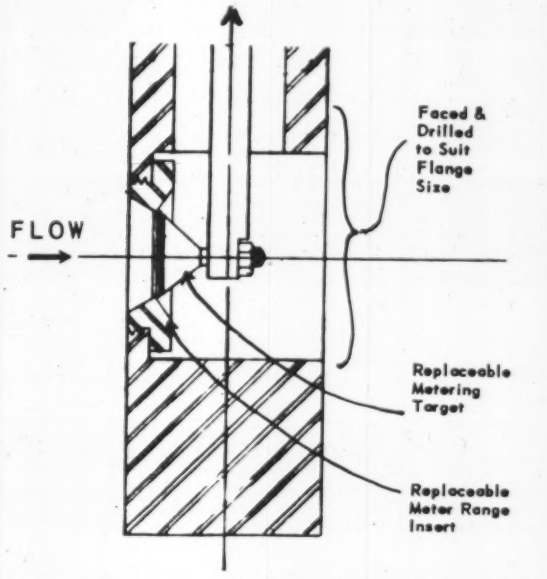
The AGASTAT is small, light, and operates in any position. Dust-proof timing chamber assures long operating life with a minimum of maintenance.

Write for Bulletin.
Dept. A1-119,

AGA

Division of Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth 3, New Jersey

For more information circle **126** on inquiry card.


TO INDICATOR THROUGH MECHANICAL LINKAGE
FLOW
Faced & Drilled to Suit Flange Size
Replaceable Metering Target
Replaceable Meter Range Insert

performance characteristics. The instrument is a variable area Flowmeter. The metering target swings about the outboard pivot bearing, its position relative to the tapered meter range insert being directly proportional to flow rate. Thus it has inherent wide rangeability, essentially constant pressure drop, a linear measurement signal, and low sensitivity to the effect of varying fluid viscosities. *(From new 4-page brochure, DevicEngineering Co., 1701 Walnut St., Phila. 3, Pa.)*

For this literature circle **407** on inquiry card.

SAVE MONEY and END COSTLY WORK STOPPAGES!

ASKANIA HAND-OPERATED VIBRATION RECORDER

Unequalled for efficiency and ease of operation!

- compact and light—weighs just 3¾ lbs.
- gives quick reading
- self-contained—no outside power needed
- makes a permanent on-the-spot record

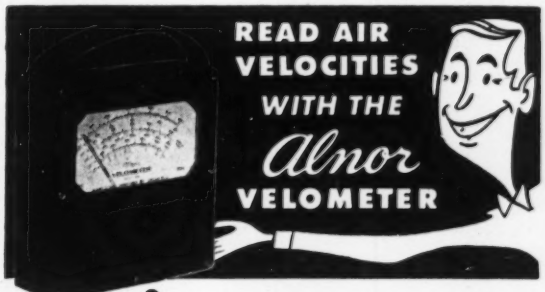
Look at these users of ASKANIA HANDVIBROGRAPH

Aluminum Corp. of America
U. S. Steel Corporation
Armour Research Foundation
Consolidated Diesel Electric Corp.
The Toledo Edison Company
Bath Iron Works Corporation
International Nickel Co., Inc.

EPIC INC **Distributorships still available**

154 Nassau St., New York 7, N.Y.

For more information circle **128** on inquiry card.



it's fast . . . you get instant, precise readings directly from scale face . . . no need for reference charts or calculations. Measure air flow through ducts, grilles, motors, spray booths, etc., or in the open.

it's accurate . . . brings laboratory standards of air velocity measurement to the production line, mine, mill . . . anywhere. Needs no special care or handling . . . anyone can use it and get accurate results.

it's portable . . . completely self-contained, hand-held. Rugged construction and sturdy case protect the Velometer from usual hazards of portable use. Available in scale ranges to 24,000 f.p.m. Wide selection of jets and fittings assures adaptability of Alnor Velometer to your application. Get full details and prices, write for Bulletin 2448-G. Illinois Testing Laboratories, Inc., Rm. 518, 420 N. La Salle St., Chicago 10, Ill.

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **127** on inquiry card.

These CEC miniature precision instrument-type

pressure pickups

cover a wide performance range

Consolidated pressure pickups feature a-c or d-c excitation—full-scale pressure ranges from 5 to 5,000 PSI—linearity within 1%—negligible sensitivity to acceleration and vibration—wide temperature range from −65°F to +250°F—output 20 millivolts with 5-volt excitation—flush-type diaphragm as standard construction—stainless steel, corrosion-resistant construction—overload protection—high frequency response—variable-resistance types—calibration certificate with each pickup. Electrical principle is unbonded strain-gage windings connected in a four-arm bridge as the active element. Write for Bulletin CEC 1552-X1 and price list.

Pickup Type	*Range*	*Dimensions*
4-310 gage pressure pickup	5 to 250 PSI	0.5" diam. x 0.7"
4-311 gage pressure pickup	5 to 5,000 PSI	0.625" diam x 0.875"
4-312 absolute, differential or gage pressure pickup	5 to 250 PSI	0.5" diam x 0.7"

Consolidated Engineering CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

For more information circle **129** on inquiry card.

COMPRESSED AIR AND GAS COME OUT OF THE LOGAN

ARIDIFIER

Scrubbed CLEAN AND DRY

INSTALL ARIDIFIERS ON LINES SERVING

- Paint Spray Guns
- Air Tools
- Air Hoists
- Foundry Jolting Machines
- Sand Blasting Tools
- Sand Blasting Rooms
- Metal Spray Guns . . . or Wherever the line must deliver clean, dry air or gas

On any air or gas line 92% of the dirt, oil, scale and water that enter the Aridifier is trapped and removed from circulation. The Aridifier's patented centrifugal-baffle action scrubs air and gas clean and dry . . . protects equipment, prevents freezing, fouling, corrosion and caking, produces best results with spray gun and air tool operations, etc. Easy to install. Self cleaning. Maintains itself. 10 models available. Capacity 7 CFM to 17,000 CFM.

Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action.

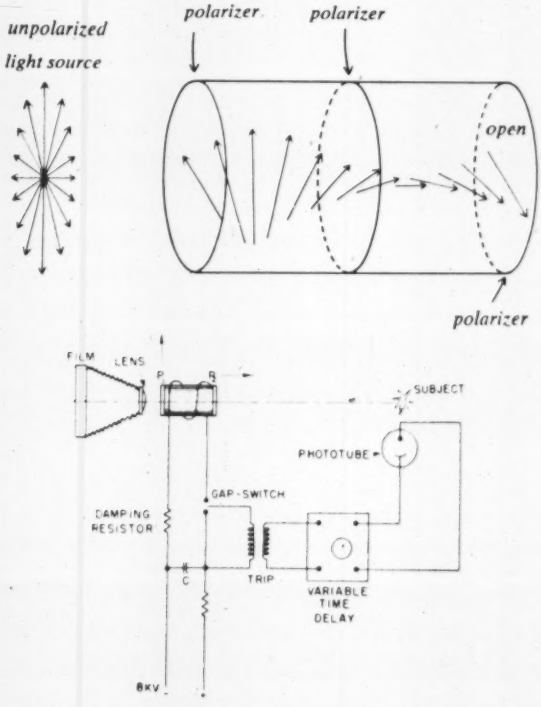
Write for This Catalog Now!

Logan ENGINEERING CO.
4921 W. Lawrence Ave., Chicago 30, Ill.

For more information circle 130 on inquiry card.

Microsecond Shutter

The Rapatronic shutter stops the action of even an h-blast, at any chosen fraction of a microsecond.



Now Save 36% On Installation Time

with IMPERIAL Hi-Duty TUBE FITTINGS

Just push tube into fitting without removing nut and tighten . . . that's all.

Furnished in Brass and Aluminum, For Tubing 1/8" to 1" O.D.

See Your Supply House

Ask for Bulletin No. 3002

Repeated, thorough tests reveal that MPERIAL HI-DUTY FITTINGS can ɔe assembled in 36% less time than regular COMPRESSION TYPE FITTINGS . . . and in 71% less time than FLARE TYPE FITTINGS. These are spectacular savings.

Fitting is furnished with integrated nut and sleeve assembled. To get a tight joint, simply insert tube into fitting and tighten nut. No loose sleeve to drop.

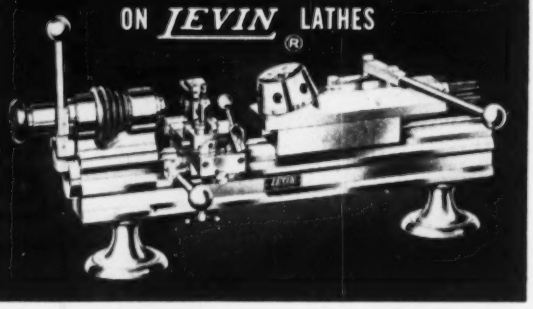
MAKES FAR STRONGER JOINTS because sleeve is always in perfect alignment and because its design minimizes deformation of tubing. Hi-Duty Fittings remain leakproof even under severe service; withstand over 5 times as much vibration as ordinary compression or flared fittings.

THE IMPERIAL BRASS MFG. CO., 1204 W. Harrison St., Chicago 7, Ill.
In Canada: 334 Lauder Ave., Toronto, Ontario

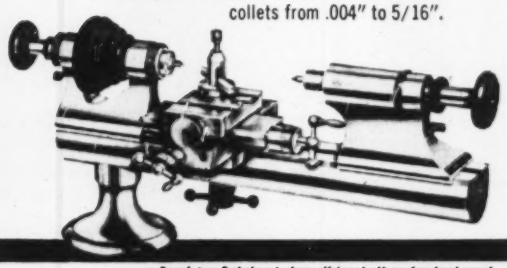
IMPERIAL — Pioneers in Tube Fitting and Tube Working Tools

For more information circle 131 on inquiry card.

SMALL INSTRUMENT PARTS ARE MADE BEST ON LEVIN (R) LATHES



Twenty-three models for all types of work. 4" swing, Bed Length 12" or 18"; over 100 stock sizes of collets from .004" to 5/16".



Send for Catalog L describing Lathes for tool work, second operations; turrets and full line of accessories.

LOUIS LEVIN & SON, INC., 3610 S. Broadway, Los Angeles 7, Calif.

For more information circle 132 on inquiry card.

Figure 1 illustrates how crossed polarizers are used in the Rapatronic shutter (two are usually used, three for an h-blast) to keep out light except during an extremely short interval. When closed, the three-polarizer shutter allows transmission of only one-billionth of the light from an explosion. When open, it allows only one-thirtieth of the light to pass . . . and that for only a fraction of a microsecond!

Figure 2 is a schematic diagram of a single-element Rapatronic shutter with two polarizers, P_1 and P_2. When light from the explosion strikes the photocell, it generates a signal that passes through a variable time delay and triggers the condenser-discharge circuit. Electrical energy, stored in capacitor C at high voltage, is released very rapidly and surges through the coil. The resulting magnetic field rotates the polarized light . . . opening the shutter.

Sensitivity of the photocell trigger-circuit is controlled by a ten-turn Model A Helipot of standard ($\pm 0.5\%$) linearity, using a Model RB Duodial for calibration.

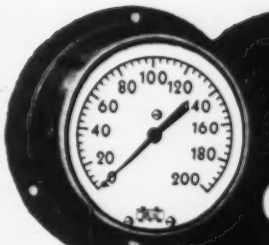
Time delay from photocell pick-up to shutter operation is continuously variable from 0 to 100 microseconds. This is controlled by a Model A Helipot of 0.1 percent linearity, using a Model W10 Duodial for calibration. (*From new 8-page issue No. 6 of "Helinews", Helipot Corp., S. Pasadena, Calif.*)

For this literature circle **408** on inquiry card.

Magnetic Amplifiers

Federal servomechanisms range in output from small ½-watt motors to motors of several hundred watts, at either 60 or 400 cycles. The control of speed, torque, braking, etc., of fractional horsepower motors within fractions of one-percent can be accomplished through the use of Federal magnetic amplifiers.

(For photoelectric applications), a two-stage magnetic amplifier counter receives its signal from a photo tube.



THE *Right* GAUGE FOR YOUR SPECIFIC NEEDS

MARSHALLTOWN

• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

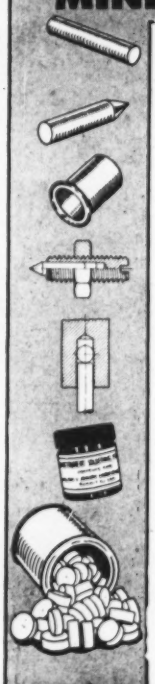
WRITE TODAY FOR COMPLETE INFORMATION.

PRESSURE, VACUUM, COMPOUND, ALTITUDE, COMBINATION, DIAPHRAGM, HYDRAULIC, AND SPECIAL PURPOSE GAUGES, DIAL THERMOMETERS, (VAPOR TENSION OR BI-METAL)

MARSHALLTOWN MFG. CO.
800 EAST NEVADA ST. • MARSHALLTOWN 3, IOWA

For more information circle **134** on inquiry card.

MINIATURE PARTS



CUSTOM MANUFACTURE OF SMALL PARTS

• Shafts, Staffs and Pivots of Special Pivot Steel, Heat-Treated and Metallographic-Polished. • Tubular Products up to ⅜" Diameter, Cut, Flared, Swaged, Formed and Burr-Free Alloy or Silver Plated. • Screw-Machine Products up to 3/16" Diameter. • Roll-Threading and Knurling to Close Tolerances. • Centerless and Surface Grinding with Special Facilities for Ceramic Rods and Shapes. • Light Punch-Press Work.

SERVICES FOR CUSTOMERS' PARTS

• A Multitude of Services are Available for Customers' Parts at Any Stage of Manufacture. These Include: Controlled-Atmosphere Heat-Treating, Centerless Grinding, Surface Grinding, Knurling, Thread-Rolling, Swaging, Drilling, Milling, Burr Removing, Metallographic, Polishing, Barrel-Plating in Alloy or Silver.

ASSEMBLY SUPPLIES

• "Welton" Non-Corrosive Instrument Solder Paste. • "Weltonoil" Treated Buttonwood Pith.

APPARATUS DESIGN SERVICES

In Connection with the Design and Fabrication of Precision Miniature Parts.

ENGINEERING ASSISTANCE ON ALL ITEMS

Welton V. Johnson
ENGINEERING COMPANY INC.
87 SUMMIT AVENUE • SUMMIT, N. J.

For more information circle **133** on inquiry card.

PHOTRON

Console Recorder...

• **NOW, CURVILINEAR AND RECTILINEAR* recordings in ink with the Model F6C recorder.**
The oscillograph is available in either four or six channel with a large range of chart speeds.
Equipment is adaptable to computer recordings.
Oscillograph may be had without console.
Curvilinear electric recording available.

*Patented

PHOTRON INSTRUMENT COMPANY
6516 Detroit Ave. • Cleveland 2, Ohio

For more information circle **135** on inquiry card.

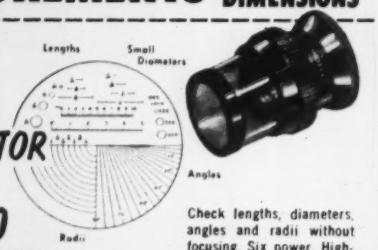
MAKE QUICK, ACCURATE MEASUREMENTS OF SMALL DIMENSIONS

INDECO

POCKET COMPARATOR

Only $22.50

POSTPAID COMPLETE WITH GENUINE PIGSKIN CASE

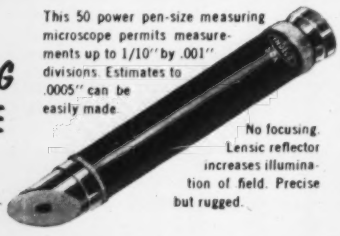


Check lengths, diameters, angles and radii without focusing. Six power. Highest quality, lowest price. Guaranteed accurate.

INDECO

MEASURING MICROSCOPE

Only $7.95 POSTPAID



This 50 power pen-size measuring microscope permits measurements up to 1/10" by .001" divisions. Estimates to .0005" can be easily made.

No focusing. Lensic reflector increases illumination of field. Precise but rugged.

15-DAY FREE TRIAL. ORDER TODAY DIRECT OR SEND FOR COMPLETE INFORMATION.

INDECO **INTERNATIONAL DEVELOPMENT COMPANY**
1 South Road Street, East Riverton, N. J.
DEALERS INQUIRIES INVITED

For more information circle **136** on inquiry card.

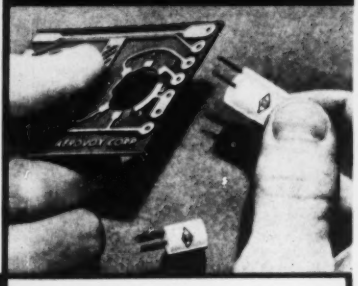
PW SERIES

CINEMA *resistors*

for

PRINTED WIRING AND AUTOMATION

A "first" in printed wiring component design. Precision wire-wound resistors in accuracies from 1% to .05% in resistances from .1 Ohm to 9 Megohms. Write for Bulletin C1034 covering the new PW Encapsulated Resistor.



CXE **CINEMA ENGINEERING CO.**
DIVISION AEROVOX CORPORATION
1100 CHESTNUT ST. • BURBANK, CALIF.

For more information circle **137** on inquiry card.

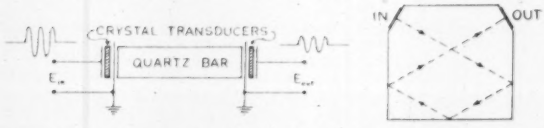
BRIEFS—CONTINUED

(For temperature control). Federal's temperature control unit receives its signal from an AC bridge, one arm of which is a temperature-sensitive bulb. A change of ±0.5 F. will cause an unbalance in the bridge of sufficient magnitude to actuate transistor voltage-amplifying stages, driving a demodulator which determines increase or decrease in temperature. The information is passed on to a magnetic amplifier-operated relay, raising or lowering temperature as required. (*From new 4-page Form F-642, Federal Tel. & Radio Co., 100 Kingsland Rd., Clifton, N. J.*)

For this literature circle **409** on inquiry card.

Delay Lines

Andersen quartz ultrasonic delay lines are made over a wide range of time delays. Echo type lines have been made as short as 0.5 micro-second. Double-ended lines as long as 3.3 milliseconds have been constructed. . . . For a delay of

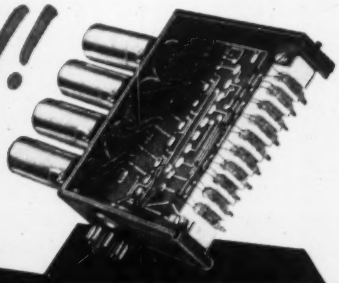


1,000 microseconds a bar of quartz 148.2 inches long would have to be used if the design of Figure 1 were followed. Instead, rectangular or polygonal shaped plates of quartz are used, and the ultrasonic beam follows a folded path, being reflected from the sides of the plates. In most designs the beam actually intersects itself many times. The designs are referred to as "configurations". A simple rectangular configuration is shown.

Ultrasonic delay lines may have carrier frequencies anywhere in the range from several megacycles to 100 mega-

NEW!

PRINTED CIRCUIT LOWERS COST on... Detectron



DECIMAL DECADE TOTALIZER

Incorporating printed circuitry into the TU-100P makes it possible to reduce the selling price by producing more uniform units, faster and more efficiently. Greater operating stability through better heat dissipation made possible by improved physical layout. Standard octal plugs assure adaptability to most existing high speed counting equipment.

Direct illuminated read-out; pulse pair resolution — 5 microseconds; maximum counting rate — 100,000 per sec.

A Complete Line of:
FREQUENCY COUNTERS
RADIATION SCALERS
DECADE TOTALIZERS • ACCESSORIES

COMPUTER-MEASUREMENTS Division of THE Detectron CORP.
5420 Vineland, Dept. 80-B, North Hollywood, Calif.

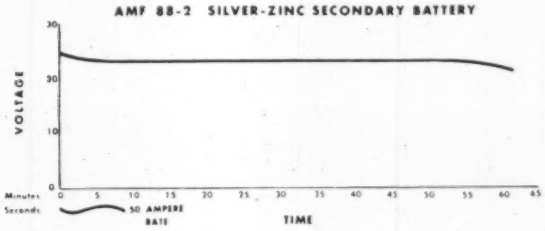
For more information circle **138** on inquiry card.

cycles. (*From new 16-page Technical Bulletin 54, Andersen Laboratories, Inc., 39 Talcott Rd., W. Hartford 10, Conn.*)

For this literature circle **410** on inquiry card.

Silver-Zinc Batteries

The silver-zinc system offers weight and volume efficiencies greater than those of any other battery system. . . . While AMF Silver-Zinc Batteries are designed for either



high rate or low rate discharge, they are especially noted for their ability to be discharged at extremely high rates. . . . An outstanding advantage of AMF Silver-Zinc Batteries is the unusually flat voltage curve which prevails at all discharge rates. Voltage variation from the nominal is less than 2½% over a temperature range of 100 F. (*From new 6-page brochure, American Machine & Foundry Co., 261 Madison Ave., N. Y. 16, N. Y.*)

For this literature circle **411** on inquiry card.

3-D Cams

These "3-D" cams make available to the user a compact unit which continuously and accurately satisfies an arbitrary function: $z = f(x, y)$, where x and y are independent variables (inputs), and z is the dependent variable.

NOW — a data recording tape that's guaranteed

DEFECT-FREE!

Type **EP audiotape** *provides the EXTRA PRECISION that you need for dependable magnetic data recording*

TYPE EP Audiotape is manufactured and tested to meet the most exacting standards of quality, uniformity and freedom from dropouts or surface imperfections. Subjected to repeated checks on an automatic defect counter, it is guaranteed *defect-free!*

Packed in Polyethylene bags and magnetic-shield metal cans. Available on cellulose acetate base (1½ mil) or Mylar* polyester film, in 1, 1½ or 2 mil base thickness. Standard widths from ¼ inch up — to your specified tolerances.

**Du Pont Trade Mark*

AUDIO DEVICES, Inc.
444 Madison Ave., New York 22, N. Y.

Send for Bulletin No. 207

For more information circle **140** on inquiry card.

PRECISION GEARS?
ROLL TEST THEM RAPIDLY ACCURATELY with the
SCHERR 5" FINE PITCH GEAR TESTER

So economically priced they can be placed alongside each Gear Cutter as well as in the Inspection Dept.

COMPLETE WITH HIGH CENTER ATTACHMENT..... **$385**

Quickly reveals Runout in Pitch Line, Spacing Errors, Errors in Tooth Form, Running Quality Generally.

Send for Illustrated Folder - Code GIKNA

GEORGE SCHERR CO., Inc.
COMPLETE LINE OF PRECISION INSTRUMENTS
200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **139** on inquiry card.

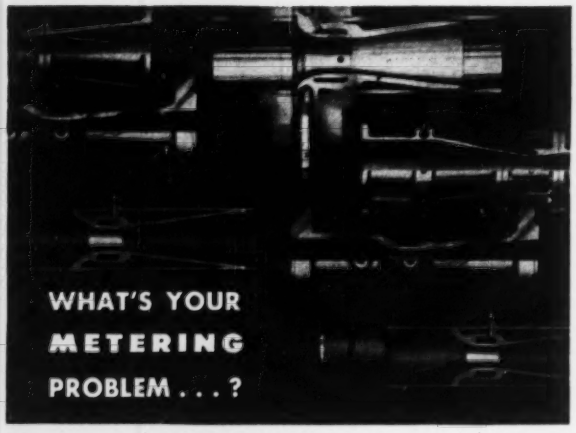
"LIQUIDS WORTH STORING ARE WORTH MEASURING" with a
LIQUIDOMETER Tank Gauge

- FOR GAUGING LIQUIDS OF ALL KINDS
- 100% AUTOMATIC
- APPROVED BY UNDERWRITERS' LABORATORIES

WRITE FOR COMPLETE DETAILS

THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE., LONG ISLAND CITY, L.I., N.Y.

For more information circle **141** on inquiry card.



BUILDERS can help you, whether your metering problem involves slurries, corrosive fluids, collodial solutions, trade wastes, air, steam, gases, or water. High pressures, high temperatures, minimum pressure losses — these and other job conditions are readily solved by Builders Flow Nozzles and Tubes. Our standard designs answer all types of metering requirements. Units are available in special metals or with Saran lining for corrosive applications.

Address "Nozzles and Tubes" for complete information. Builders-Providence, Inc. (Division of B-I-F Industries, Inc.), 422 Harris Ave., Providence 1, Rhode Island.

BUILDERS-PROVIDENCE
DIVISION OF B-I-F INDUSTRIES, INC.
METERS FEEDERS CONTROLS

For more information circle **142** on inquiry card.

For more information circle **143** on inquiry card.

BRIEFS—CONTINUED

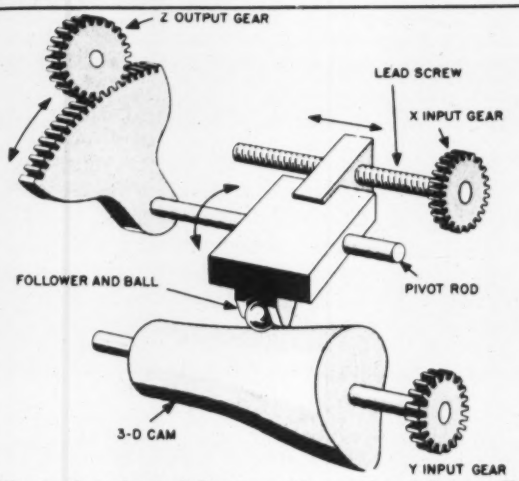


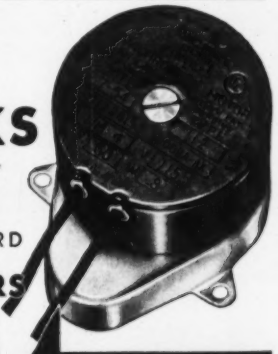
Illustration shows 3-D cam with angular follower. Follower is positioned by lead screw (x input) and by cam rotation (y input). Follower movement rotates pivot rod which, in turn, causes sector gear to rotate output gear (z). (*From new 4-page brochure CB-754, Ford Instrument Co., Sperry Corp., 31-10 Thomson Ave., L.I.C. 1, N. Y.*)

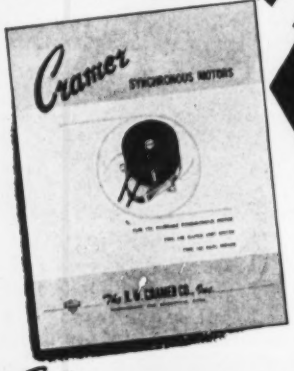
For this literature circle **412** on inquiry card.

0 to 250 kc. Oscillograph

Solution to many of today's engineering problems, the new Wm. Miller CR-1 Cathode-Ray Recording Oscillograph extends the useful range of multi-channel recording from static conditions to frequencies as high as 250,000 cycles per second. A precisely correlated time history of up to 16 high-frequency phenomena is obtained on a single 8"-wide rec-

NOW!...
4-6 WEEKS DELIVERY
ALL STANDARD Cramer MOTORS





WRITE FOR NEW BULLETIN

The Type 112 Synchronous Motor recently announced by The R. W. Cramer Company is now in full production. Expanded facilities for standard motors now make possible prompt deliveries of small or large volume orders.

Write for new Bulletin PB-110.

Cramer TIMING DEVICES
SPECIALISTS IN TIME CONTROL
The R. W. CRAMER CO., *Inc.*
BOX 5, CENTERBROOK, CONNECTICUT

14CR54

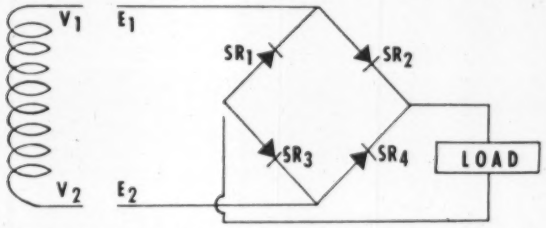
For more information circle **144** on inquiry card.

ord. . . . chopper-stabilized DC amplifiers raise the signal level to that required by the deflection amplifiers. (*From new 4-page brochure, Wm. Miller Instruments, Inc.*, 325 *N. Halstead Ave., Pasadena* 8, *Calif.*)

For this literature circle **413** on inquiry card.

Bridge Rectifiers

The bridge rectifier is probably the most commonly used metallic rectifier circuit. That is, it is used in a wider variety of applications and may attribute its popularity to its several advantages, some of which are enumerated below:



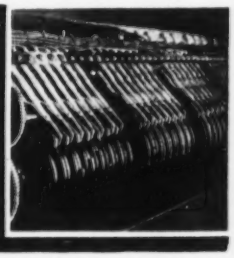
1. It may be connected directly to any ac voltage source (does not need a center tapped winding) and will provide a dc voltage essentially equal to the applied ac voltage.
2. Its cost is usually favorable in comparison with other circuits when cost of transformer is included.
3. Leakage current passed by the rectifier does not pass through the dc load.
4. The ac source (transformer winding) is not part of the dc circuit.
5. Its dc blocking rating is high, as seen by reflected dc voltages. (Two arms in series as viewed from dc load.)

(*From new 4-page issue RN-654 of International Rectifier News, International Rectifier Corp.*, 1521 *E. Grand Ave., El Segundo, Calif.*)

For this literature circle **414** on inquiry card.

multi-circuit sequence control

custom-built from standard parts



atc®

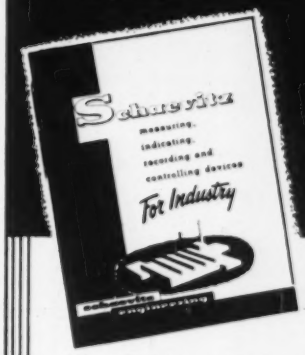
CAM TIMERS

Automatic control of sequence and duration is simple, accurate, easily and quickly adjusted or changed on ATC Cam Timers. Cam cycles of any time interval and leaf-spring contacts of all types available.

For complete data, write for Bulletin No. N-20. Automatic Temperature Control Co., 5224 Pulaski Avenue, Phila. 44, Pa.

For more information circle **145** on inquiry card.

Wherever PRECISION MEANS SUCCESS...



FREE CATALOG

● Schaevitz measuring, indicating, recording and controlling devices can be important to you.

Write today for your free copy of this new, illustrated catalog which describes the complete line of SCHAEVITZ precision products. Valuable wherever products of this type are used, the fact-filled pages carry specification and application instructions on Linear and Angular Accelerometers, Single Variable Inductance Accelerometers, Linear Variable Differential Transformers, Rotary Transformers, Rotary Accelerators, Pressure Transducers, Complete Recorder Systems and Slip Ring Assemblies.

schaevitz engineering

P. O. BOX 505, CAMDEN 1, NEW JERSEY
MErchantville 8-5353

For more information circle **146** on inquiry card.

the most widely used Electronic Supply Guide

free send for it

ALLIED'S COMPLETE 308-PAGE 1955 CATALOG

your guide to the world's largest stocks of ELECTRONIC SUPPLIES FOR INDUSTRY

Simplify and speed *all* your purchasing of electronic supplies and equipment. Send your orders to us for fast shipment from the world's largest stocks of electron tubes (all types), test instruments, audio equipment, electronic parts (transformers, capacitors, controls, etc.). Our expert Industrial supply service saves you time, effort and money. Send today for your FREE 1955 ALLIED Catalog—the *complete* up-to-date guide to the world's largest stocks of quality Electronic supplies for Industrial use.

One complete dependable source for everything in electronics

ALLIED RADIO
100 N. Western Ave., Dept. 50-L-4
Chicago 80, Illinois

For more information circle **147** on inquiry card.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1865.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Systems Control Equipment. New 16-page Brochure CEC-1304 describes custom engineering of electronic instrumentation tailored to specific industrial, scientific and military needs; case histories of instrumentation systems, and applications.—Consolidated Engineering Corp., Pasadena 15, Calif.

Circle **415** on inquiry card.

Process, Analytical, Testing Instruments. New 68-page Catalog GEC-1016A presents maker's large line of instruments covering fields of electrical testing, chemical analysis, color, force, temperature, pressure, radioactivity, and power-supply instrumentation.—General Electric, Schenectady 5, N. Y.

Circle **416** on inquiry card.

Process Instruments. New 12-page Catalog 1 describes maker's complete line of process instrumentation for measuring and controlling process variables—temperature instruments, liquid level instruments, electric, pneumatic, etc.—Fischer & Porter Co., 172 Jacksonville Rd., Hatboro, Pa.

Circle **417** on inquiry card.

Annunciator Systems. New 8-page Bulletin 200 presents "50L" system including chassis, flasher, reset button for complete process monitoring. —Panalarm Products, Inc., 6312 N. Broadway, Chicago 40, Ill.

Circle **418** on inquiry card.

Temperature Limit Control. New 2-page Bulletin F-6313 describes "Series 700 Limitrols" which prevents overshooting of critical temperatures.—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle **419** on inquiry card.

Transmission Instruments. Pneumatic Transmitter-controller. New 4-page Bulletin A106 describes and illustrates maker's "Metagraphic" recorder with continuous valve-position indication.—Bristol Co., Waterbury 20, Conn.

Circle **420** on inquiry card.

Process Telemeter. New 6-page Bulletin 33-A-85a presents description, operation, specifications, photographs and diagrams of maker's new impulse-duration telemeter system.—Foxboro Co., Foxboro, Mass.

Circle **421** on inquiry card.

Atmosphere Control. New 12-page Catalog TD4-620(2) presents principle and operation of maker's method for continuous, automatic measurement and control of carbon inside furnace retort during heat treating cycles.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **422** on inquiry card.

Manual-hydraulic Control. New set of five 1-page bulletins present description and diagrams of maker's "Hydra-Trol" remote controls—lever-controlled hydraulic-cylinder positioning devices.—Trimount Instrument Co., 3119-21 West Lake St., Chicago 12, Ill.

Circle **423** on inquiry card.

Transmitter Control Systems. New 8-page brochure describes and pictures maker's remote control system for commercial broadcast transmitters.—Rust Industrial Co., Inc., 608 Willow St., Manchester, N. H.

Circle **424** on inquiry card.

Automatic Lubrication. New 4-page Bulletin OF-15M-8-54 describes and illustrates maker's lubricators, distribution systems and meter-units for automatic lubrication systems.—BiJur Lubrication Corp., Rochelle Park, N. J.

Circle **425** on inquiry card.

MOTORS

Induction Motors. New 28-page Catalog EI-3A presents maker's induction motors designed to provide high output at high efficiency for a given frame size. Also torque motors for use in recording devices, machine tools, valve and switch operations.—Electric Indicator Co., Inc., Camp Ave., Springdale, Conn.

Circle **426** on inquiry card.

Commutator Motors. New 22-page Catalog EI-2A covers electrical and physical characteristics of maker's line of commutator motors and governor units.—Electric Indicator Co., Inc., Springdale, Conn.

Circle **427** on inquiry card.

Motors, Tape Duplicator. New 4-page issue of "Motorgram" (VOl. 34 No. 5) presents articles on mass reproduction of pre-recorded tapes, and reversing fractional-horsepower motors.—Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

Circle **428** on inquiry card.

Motors. New 4-page Bulletin 943 is rating, speed, frequency and price chart for maker's induction, gear, direct-current and single-phase motors. —Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

Circle **429** on inquiry card.

Constant-speed Motor. New 2-page Leaflet, Form SC-23 describes maker's "SC-23" motor for continuous-duty applications calling for constant speed under varying voltage, load, and ambient conditions.—Dalmotor Co., 1342 Clay St., Santa Clara, Calif.

Circle **430** on inquiry card.

Synchronous Motors. New 4-page Catalog 403-2 describes and illustrates maker's 19 models of hysteresis synchronous motors for high-fidelity recording and reproducing equipment. —Technical Development Corp., 4060 Ince Blvd., Culver City, Calif.

Circle **431** on inquiry card.

VALVES

Valves, Regulators. New 4-page bulletin describes and illustrates automatic regulators for use in heating, power generating and industrial processing, including high- and low-pressure reducing valves, temperature regulators, relief and lever-operated control valves and an air-actuated pilot —Atlas Valve Co., 280 South St., Newark 5, N. J.

Circle **432** on inquiry card.

Solenoid Valves. New 4-page Bulletin 8210A describes maker's two-way solenoid valves for controlling air, gas, water, light oil, and other non-corrosive fluids.—Automatic Switch, 391 Lakeside Ave., Orange, N. J.

Circle **433** on inquiry card.

Sampling Valve. New 2-page bulletin describes "Little Sam" packless, self-closing hand-operated sampling valve for liquids, hot solvents, hot caustics, etc.—Jordan Regulator Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle **434** on inquiry card.

Diaphragm Valves. New 20-page Catalog SV-1951 illustrates and describes maker's diaphragm valves operated by handwheel, lever, and power mechanisms.—Grinnell Co., Inc., Providence 1, R. I.

Circle **435** on inquiry card.

Steam Trap. New 2-page Bulletin 2098-B describes maker's steam trap for steam mains and separators; headers and soot blower pipes; engine and turbine stop valves, etc.—Sarco Co., Inc., Empire State Bldg., N. Y. 1, N. Y.

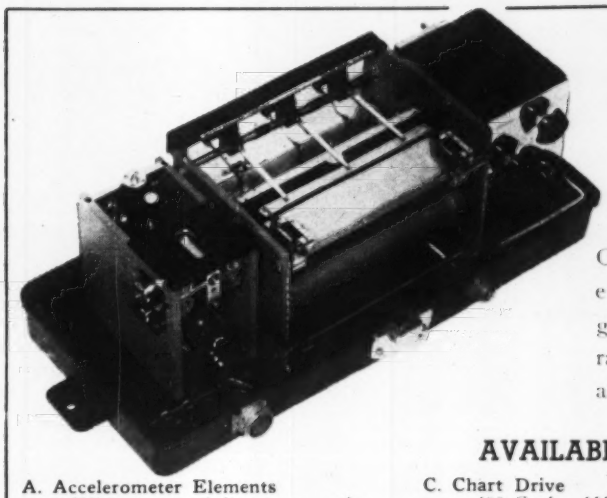
Circle **436** on inquiry card.

Release Valves. New 2-page Bulletin 654 describes and illustrates maker's new air-release valves. Capacity table shows cu. ft. of free air handled by various air-release valves.—V. D. Anderson Co., 1935 W. 96 St., Cleveland 2, Ohio.

Circle **437** on inquiry card.

Hydraulic Servo Valve. New 2-page illustrated Bulletin S103-8-54 covers description and specifications of maker's "Model 13" single-stage hydraulic servo valve.—Auto Control Laboratories, 1107 S. Fremont Ave., Alhambra, Calif.

Circle **438** on inquiry card.



THREE COMPONENT ACCELEROMETER

One of the finest, direct-recording, mechanical accelerometers built. Thirty-five years' experience have gone into the design of this ruggedly built, accurate and dependable instrument. Available in one and two component accelerometers.

AVAILABLE WITH THE FOLLOWING FEATURES:

A. Accelerometer Elements
Wide range of frequency and G.
Elements are ball bearing mounted for minimum hysteresis loss.
Accuracy is 2% of full scale.
All elements are linear and are damped.

B. Recording Chart
7" Wide, wax coated, 2" trace per G.
Instantaneous records — no developing required.

C. Chart Drive
400 Cycle—115 volt synchronous for direct or remote operation.
60 Cycle—115 volt synchronous for direct or remote operation.
Spring driven motors for 8, 16 or 30 day operation.

D. Chart Speed
½"/hour to 60"/minute in single or two speed selection.
Wider ranges furnished on request.

E. Recording Styli
Heat or pressure recording type, sapphire tipped.

F. Usage
Package testing, impact testing, riding qualities of all types of vehicles for land, sea, aircraft and missile work.

G. Size and Weight
16"x8"x8"—Weight, 18 pounds.

For further details write:

Impact Register Company, P. O. Box 445, Champaign, Ill.

MAKERS OF VGTA FLIGHT RECORDERS, IMPACT REGISTERS AND RIDE RECORDERS

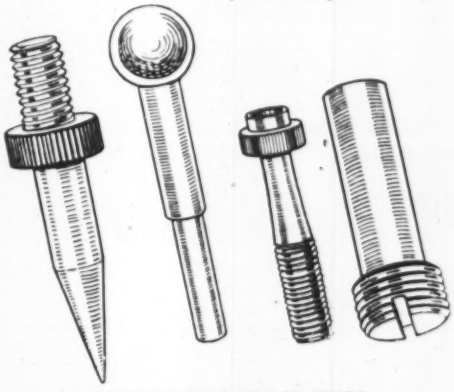
For more information circle **148** on inquiry card.

Serving Industry

with **AUTOMATIC SCREW MACHINE PARTS**

ALL SECONDARY OPERATIONS

Drilling-Tapping-Milling-Cylindrical and Centerless Grinding
Heat Treating and Plating



CUTTING DIES OF ALL KINDS
Machine Shop Work — Jigs and Fixtures

PROGRESSIVE SERVICE CO.

Main Office & Factory
2743 Locust St.
St. Louis, Mo.
Tel. Newstead 4300

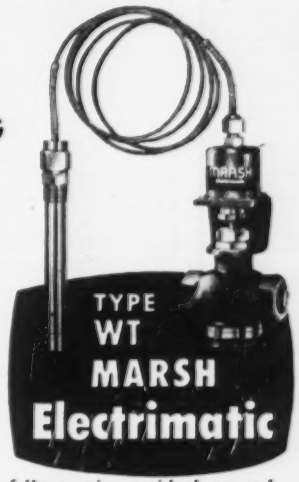
Branch Office & Factory
80 S. Cameron St.
Harrisburg, Pa.
Tel. 2-8146

For more information circle **149** on inquiry card.

MARSH QUALITY

. . . in a Temperature-actuated

REGULATING VALVE



Smooth, modulating control

— for brine lines in cooling systems

— for condensers where pressure line is not desired

A temperature actuated regulating valve you can depend on—the Marsh-Electrimatic Type WT for pressures up to 150 psi; water, brine or steam. It opens as temperature rises, closes as temperature falls, to give an ideal, smooth, modulated control. Can be mounted in any position; serviced without breaking connections. Seat beads are monel to eliminate wire drawing. Sturdy, two-ply bellows assures extra service life. Temperature ranges of 20°F.-60°F.; 60-100, 100-140, 140-180, 160-220. All standard sizes from ⅜" through 4". All styles of temperature bulbs.

Ask for latest data

MARSH INSTRUMENT CO. *Sales affiliate of Jas. P. Marsh Corporation*
DEPT. 42, SKOKIE, ILL.

For more information circle **150** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Valves. New 16-page illustrated Bulletin 1010 covers maker's 4-way hand, foot, power and solenoid-operated valves. Also new line of pilot valves.—Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles 15, Calif.

Circle **439** on inquiry card.

Discharge Valve. New 6-page Bulletin T-54-5M lists features and specifications of maker's stainless-steel truck-tank discharge valve which eliminates heating of unloading outlets.—Chem-Valve Corp., Kenvil, N. J.

Circle **440** on inquiry card.

COMBUSTION

Wobbe Index Recorder. New 4-page Leaflet 10 describes and illustrates maker's "Sigma" English-made Wobbe-index recorder for regulating the flow of gas to the burner on basis of true heat input. (Wobbe index equals calorific valve divided by square root of sp. gr.)—Cosa Corp., 405 Lexington Ave., New York 17, N. Y.

Circle **441** on inquiry card.

Fuel-air Ratio Control. New two 2-page data Sheets ND69 (1) describes all-electric ratio control operation; Sheet ND69 (11) describes controller for pneumatic operation.—Leeds & Northrup Company, 4934 Stenton Ave., Phila. 44, Pa.

Circle **442** on inquiry card.

TEMPERATURE

Temperature Control. New 2-page Bulletin F-5358-1 describes maker's "Model 292 Capacitrols" for direct-reading temperature control to 3000 deg. F.—Wheelco Instruments, Barber-Colman Co., Rockford, Ill.

Circle **443** on inquiry card.

Thermostats. New 12-page Booklet 5-54-75 MB describes and illustrates maker's "Autostat", a thermostat used in many auto and truck engines. Includes bellows and fusion types.—Robertshaw-Fulton Controls Co., Knoxville 1, Tenn.

Circle **444** on inquiry card.

Self-Balancing Indicator. New 2-page Bulletin 61 describe and illustrates maker's electronic self-balancing indicator, including potentiometer-pyrometer and resistance-thermometer types.—Thermo Electric Co., Inc., Saddle River Township, Rochelle Park Post Office, N. J.

Circle **445** on inquiry card.

Thermistor Mounts. New 4-page issue of "hp Journal" (Vol. 5 No. 11) features article on new thermistor mounts for simplifying measurement of microwave power levels.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **446** on inquiry card.

Thermometer Calibration Baths. New 2-page Bulletin 4-A describes and illustrates maker's "Model 101-9A and 1039A" used in calibrating filled-system temperature instruments. Also "Model 1046A" for daily calibration of industrial instruments.—Hallikainen Instruments, 1341 Seventh St., Berkeley, Calif.

Circle **447** on inquiry card.

Temperature Crayons. New 6-page brochure describes maker's "Tempilstiks," crayons that tell temperatures in preheating, stress relieving, casting, tempering, forging, etc.—Tempil Corp., 132 W. 22nd St., N. Y. 11, N. Y.

Circle **448** on inquiry card.

PRESSURE

Ionization-transducer Pressure Meter. New 2-page Instrument Data Sheet 303-1 presents principles, features, and specifications for new micro-differential-pressure meter utilizing new "T-42 Ionization Transducer" recently revealed.—Decker Aviation Corp., 1361 Frankford Ave., Phila., Pa.

Circle **449** on inquiry card.

Pressure Pickups. New 2-page Brochure 4530 presents maker's pressure-actuated potentiometers for absolute or differential pressure. Also "Trimpot" subminiature dual pot and "Liniometer" miniature linear-motion pot.—Bourns Labs., 6135 Magnolia Ave., Riverside, Calif.

Circle **450** on inquiry card.

Fluctuating-pressure Transducer. New 2-page Leaflet form PT654, describes strain-gage-type fluctuating-pressure pickup, including construction and circuitry.—Electronic Engineering Associates, Ltd., 1005 Brittan Ave., San Carlos, Calif.

Circle **451** on inquiry card.

Pressure Regulators. New 6-page brochure illustrates and describes maker's regulators "Type GA and Type SA" for liquids and light slurries.—W. A. Kates Co., 430 Waukegan Rd., Deerfield, Ill.

Circle **452** on inquiry card.

Pressure Control System. New 4-page Bulletin V-4001 describes and illustrates maker's blowdown tunnel system which can optimize systems in which combined transient and steady-state response accuracies are stringent.—CDC Control Services, Inc., 400 S. Warminster Rd., Hatboro, Pa.

Circle **453** on inquiry card.

Diffusion Pumps. New 8-page catalog describes and illustrates maker's diffusion, booster, mercury-vapor and mechanical vacuum pumps.—Naresco Equipment Corp., 160 Charlemont St., Newton Highlands 61, Mass.

Circle **454** on inquiry card.

WEIGHT

Load Cells. New 4-page Data Sheet 10.18-7 describes equipment using Baldwin "SR-4" load cells for indicating, recording, or controlling weights of fluids and solids in tanks.—Industrial Div. Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **455** on inquiry card.

Overload Switches, Dynamometer. New 6-page Engineering Catalog 19F describes and illustrates maker's overload signals and switches, universal tester, dynamometer "Model AN" and mechanical pressure gage.—W. C. Dillon & Co., Inc., 14606 Keswick St., Van Nuys 3, Calif.

Circle **456** on inquiry card.

Weighing, Recording. New 2-page Bulletins ED-2 and ED-3 describes maker's electronic "Model CR" and "Model C" table-model weight-recording units for use with electric load cell and mechanical lever systems or with multiple load cells without levers. Includes print out.—Fairbanks-Morse, Chicago 5, Ill.

Circle **457** on inquiry card.

PUMPS

Controlled-volume Pumps. New 22-page Bulletin 1253 discusses use of maker's controlled-volume pumps as flow controllers, ratio controllers, and final-control elements in process instrumentation.—Milton Roy Co., Station Y, 1300 E. Marmaid Lane, Phila. 18, Pa.

Circle **458** on inquiry card.

Proportioning Pump. New 6-page AP-54 illustrates and describes maker's "A Series" proportioning pump with no packing, featuring high-speed

INSTRUMENT & CONTROL CONSULTANTS

Engineering Services, Testing Laboratories and other Professional Services

Your Midwestern Engineering Facility
for the Design of
Control Panels, Instrument Panels & Cubicles

Product Design & Detail — Efficient & Dependable — Production Design Process Engineering

DEARBORN DESIGNING & MANUFACTURING COMPANY

LUzon 2-3069 — 23410 Military Rd., Dearborn 6, Michigan — LOgan 2-6621

C.O.M.S.I.P.

Specialized in control Engineering

Instrument layout—Procurement—Application—conventional and graphic panel design and construction

INSTALLATION—REVAMPING
STARTING UP—MAINTENANCE

40 Ave. Verdun • Croissy • S&O France

Your card in this space in 12 issues of INSTRUMENTS and AUTOMATION for $100, payable in advance.

valves and pulse-free flow.—Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.

Circle **459** on inquiry card.

Pumps. New 4-page Form 7280 presents dimension, materials table and sectional drawings of maker's "Class BPM" mixed-flow and "Class APL" axial-flow pumps.—Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

Circle **460** on inquiry card.

HUMIDITY

Dewpoint Recorder. New 2-page Data Sheet 10.5-1a describes maker's recorder for recording dewpoint or moisture content of gaseous atmospheres.—Industrial Div., Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **461** on inquiry card.

Hygrometer. New 4-page Brochure HY654LA describes maker's electronic dew-point hygrometer "Model 900-1" for measuring temperature at which a condensable component of a gas mixture will form dew or frost.—Burton Mfg. Co., 11201 W. Pico Blvd., Los Angeles 64, Calif.

Circle **462** on inquiry card.

Humidity Conditioning. New 4-page issue of "The Humidity Engineer" (Vol. 5, No. 3) features articles describing recent application of humidity conditioning equipment for aircraft-wind-tunnel air drying, humidity conditioning.—Surface Combustion Corp., Toledo 1, Ohio.

Circle **463** on inquiry card.

Dehydrator. Three new 2-page data sheets describes "Humi-Cap" dehydrator constructed from one piece of transparent plastic providing a controlled rate of moisture absorption. Also "Humi-Spot" humidity indicator used for indicating excessive relative humidity. Also dehydrator plug for moisture control within reciprocating engines and other equiment.—Dri-Aire, Inc., South Norwalk, Conn.

Circle **464** on inquiry card.

Condenser and Fluid Cooler. New 2-page Bulletin 123 describes maker's blower "Aeropass" for refrigerant condensing, vapor condensing in chemical processes, reflux and condensate cooling, oil cooling, etc.—Niagara Blower Co., 405 Lexington Ave., N. Y. 17, N. Y.

Circle **465** on inquiry card.

FLOW

Variable-area Flowmeter. New 4-page Bulletin 1-100 describes new "Model 1-100" flowmeter featuring orifice simplicity with variable-area advantages—wide range, linear output, constant pressure-drop and low viscosity-sensitivity.—DevicEngineering Co., 1701 Walnut St., Phila. 3, Pa.

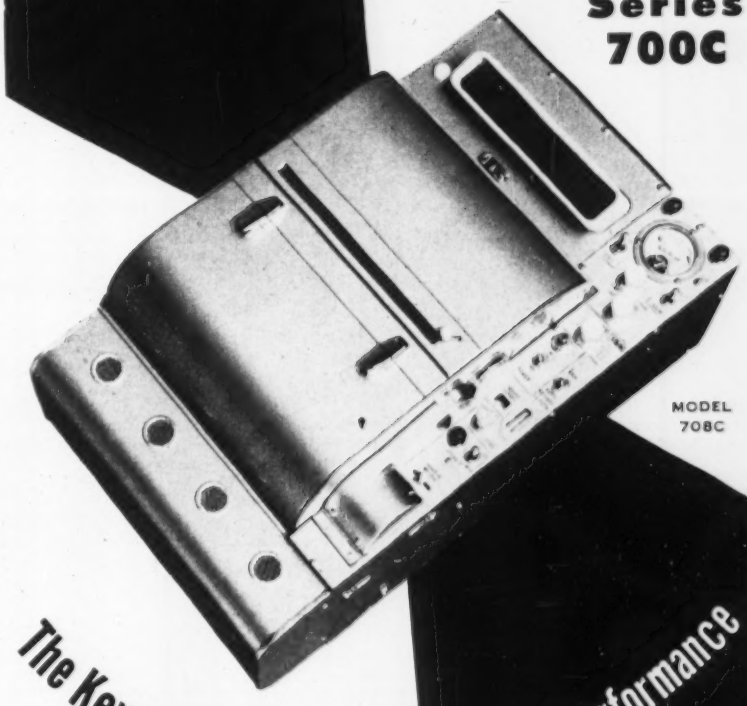
Circle **466** on inquiry card.

Electronic Flow Totalizer. New 2-page Flowmeter Specification Sheet L-2 describes maker's industrial counter for pulse or sine-wave signals used for industrial applications, including flow measurement.—Potter Aeronautical Co., Union, N. J.

Circle **467** on inquiry card.

MINNEAPOLIS
Honeywell
Heiland OSCILLOGRAPH

Series 700C



The Key to Better Product Design-Performance

This new Recording Oscillograph enables the testing engineer and scientist to solve a wide variety of industrial and laboratory problems involving the measurement and correlation of strains, stresses, vibrations, accelerations, pressures, impacts, temperatures, etc.

The 700C Oscillograph provides up to 60 separate recording channels, has record widths of 8 to 12 inches, record speeds as high as 144 inches per second and as low as .030 inches per second. The 700C accommodates our new Sub-Miniature Galvanometers and temperature controlled magnet assemblies in which a new high in stability and sensitivity has been attained.

Heiland A DIVISION OF MINNEAPOLIS-HONEYWELL

130 EAST FIFTH AVE., DENVER 3, COLORADO

For more information circle **151** on inquiry card.

INSTRUMENTATION ENGINEER

(Physicist or Electronics Engineer)

Once in a lifetime opportunity for physicist or electronics engineer with ability to design, construct and install setups used to obtain data on engine ignition and performance. Setups will be diversified so that projects might require mechanical and electronics instrumentation as required to best obtain information.

Also included will be design of auxiliary control circuits and writing of operation manual to be used by experimental department personnel.

ELECTRONICS ENGINEER OR PHYSICIST

If you have experience or ability in design, construction and evaluation of high voltage, high frequency circuits, we have an exceptional opportunity in which you will be interested.

Position requires applicant capable of designing circuits incorporating transistors, magnetic amplifiers and semi-conductors.

Interested applicants possessing necessary qualifications may apply for either of these excellent positions by writing to the Personnel Director, Electric Auto-Lite Company, Toledo 1, Ohio, outlining all pertinent data regarding responsibilities of present position, past experience, training, and salary requirements.

MANUFACTURERS' NEW LITERATURE

Flowmeters, Valves. New 4-page Bulletin 050 presents description and characteristics of maker's standard and elliptical Venturi tubes, air-release and inlet valves, and controlled-closing valves for water, sewage, and process applications.—Simplex Valve & Meter Co., 68 & Upland St., Phila. 42, Pa.

Circle **468** on inquiry card.

Flow Transmitters. New 4-page Bulletin 170 describes makers "Mag/-Nu/Matic" transmitter for pneumatic receiver or control instruments; provides fast linear response in output air pressures for every position of the rotameter metering float.—Brooks Rotameter Co., Lansdale, Pa.

Circle **469** on inquiry card.

Sight Flow Indicators. New 2-page Bulletin 3547 describes and illustrates maker's flow indicators "Style S-100 and F-910" suited to transparent or slightly opaque solutions, as well as some gases.—Jacoby-Tarbox Corp., 808 Nepperhan Ave., Yonkers, N. Y.

Circle **470** on inquiry card.

Filters. New 4-page illustrated Bulletin 16 explains use of maker's wire mesh "DeMisters" to improve performance and increase throughput capacity of process vessels handling both liquid and vapor phase materials.—Otto H. York Co., Inc., 6 Central Ave., West Orange, N. J.

Circle **471** on inquiry card.

RECORDING

Oscillographs, Testing Equipment. New 12-page issue of "Engineering News" (Vol. 4, No. 3) features articles on accessories for "RS-9, SC-16" oscillograph, theory and measurement of symmetrical components; "PS-20" pressure transducer.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.

Circle **472** on inquiry card.

Recording, Data Processing. New 12-page Catalog CEC-1301 "Data Processing Instruments" illustrates maker's complete line of data-processing equipment—recording oscillographs, galvanometers, amplifiers, power supplies, etc.—Consolidated Engineering Corp., Pasadena 15, Calif.

Circle **473** on inquiry card.

Miniature Recorder. New 12-page Bulletin 7201 describes maker's quick-connect "Tel-O-Set" miniature recorder and controller for process variables—temperatures, pressure, level. Includes high sensitivity, fast response. Industrial Div., Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **474** on inquiry card.

Geophysical Recorder. New 4-page Bulletin S-302 describes maker's "HTL" log level indicator, a calibrated, electronic voltage-indicating and measuring instrument for recording special traces on seismograph record.—Houston Technical Labs., 2424 Branard, Houston 6, Texas.

Circle **475** on inquiry card.

Bridge-type Transducers. New 8-page brochure "Instrument Notes" (No. 28) describes maker's system for monitoring over-all transduction ratio for analog recording channels employing bridge-type transducers.—Statham Labs., Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle **476** on inquiry card.

Recorder. New 2-page bulletin pictures and describes maker's recorder for pneumatic and electric transmission systems.—Bailey Meter Co., 1070 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **477** on inquiry card.

Recorder. New 4-page illustrated brochure describes maker's recorder that provides continuous chart records of four process variables.—Bailey Meter Co., 1051 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **478** on inquiry card.

Action Recorder. New 4-page Bulletin 117 pictures and describes maker's "Productograph" for recording any action which can be governed by opening or closing of conventional switch.—Simplex Time Recorder Co., Gardner, Mass.

Circle **479** on inquiry card.

Recorders. New 8-page illustrated Industrial Catalog 10 presents description and applications of maker's mechanical and electrical recorders.—Service Recorder Co., 1375 Euclid Ave., Cleveland 15, Ohio.

Circle **480** on inquiry card.

Chart Drives. New 8-page Brochure C.D. 5-54-3M describes maker's chart drives (mechanical and air driven) "Series AO7" for miniature strip-chart recorders and controllers.—Seth Thomas Clocks Div., General Time Corp., Thomaston, Conn.

Circle **481** on inquiry card.

LEVEL

Tank Gaging Equipment. New 76-page Bulletin CP 3007 describes and illustrates maker's automatic tank gages for determination of oil levels in atmospheric or low-pressure lease, field, or storage tanks. Also high-pressure automatic-shut-off tank gage.—Vapor Recovery Systems Co., 2820 No. Alameda St., Compton, Calif.

Circle **482** on inquiry card.

Liquid-level Gages. New 8-page Catalog 246 presents design, features, and schematics of maker's convex and flat scale "Truscale" remote-reading liquid-level gages.—Jerguson Gage & Valve Co., 80 Fellsway, Somerville 4, Mass.

Circle **483** on inquiry card.

Pulse-code Level Receiver. New 4-page Bulletin CP-3008 describes new pulse-code telemetering system used for liquid-level readings over distances limited only by availability of communications facilities.—Vapor Recovery Systems Co., 2820 No. Alameda St., Compton, Calif.

Circle **484** on inquiry card.

Capacitive Level Indicator. New 2-page bulletin form LI 2-854 describes maker's indicating level monitor deriving its signal from an inert capacitive-type sensing probe.—Thermo

Instruments Co., 1310 Old County Rd., Belmont, Calif.

Circle **485** on inquiry card.

SPEED, FREQUENCY

Speed Control. New 20-page illustrated Catalog GEA-6127 covers description, features and applications of maker's 1 to 200-hp. packaged speed variators.—General Electric, Schenectady 5, N. Y.

Circle **486** on inquiry card.

Velocity Pickups. Four new 2-page data sheets describe maker's "Torsiograph type 9-102" designed to detect and measure torsional vibrations from a rotating shaft; miniature self-generating velocity pickup "Type 4-118" for vibration analysis which requires a compact, light-weight pickup; velocity pickups "Types 4-102A & 4-103"; velocity pickups "Type 4-106V" for vertical vibration measurement and "Type 4-106H" for horizontal vibration measurement.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **487** on inquiry card.

Gear Heads. New 10-page catalog covers description, specifications, and diagrams of maker's gear heads, gear trains and speed reducers.—Feedback Controls, Inc., 1332 North Henry St., Alexandria, Va.

Circle **488** on inquiry card.

Tachometer Generator. New 2-page Catalog Sheet 1854 describes maker's new direct-current tachometer generator which can be used with any d-c. voltmeter having sensitivity of 1000 ohms or more per volt.—Servo-Tek Products Co., Inc., 1086 Goffle Rd., Hawthorne, N. J.

Circle **489** on inquiry card.

Tachometers. New 4-page Bulletin 1046 describes maker's hand tachometers (centrifugal and chronometric type) and Standco hand tachoscope, an accurate counter and high-grade stop watch.—Herman H. Sticht Co., Inc., 27 Park Place, N. Y., N. Y.

Circle **490** on inquiry card.

OPTICAL

Photometer. New 20-page Bulletin B-P-1000 describes and illustrates maker's light-scattering photometer 1000 Series for measurement of micro-scattering, micro-fluorescence, micro-luminescence, and low transmittance and reflectance of dark materials.—Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila. 40, Pa.

Circle **491** on inquiry card.

High-speed Framing Cameras. New 4-page Bulletin (Form 189) describes and illustrates maker's framing cameras for studies of combustion, plastic and elastic deformation, and shock-wave phenomena. Cameras are capable of 1.2 million and 2.4 million frames per second.—Beckman & Whitley, Inc., 1099 E. San Carlos Ave., San Carlos, Calif.

Circle **492** on inquiry card.

Meets A.P.I.* Standards for CUSTODY TRANSFER SERVICE

* American Petroleum Institute

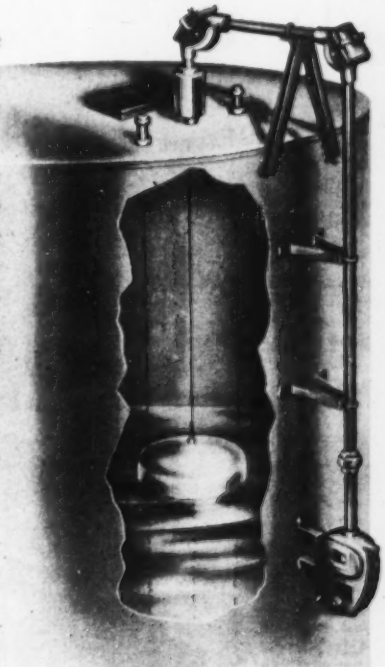
"Varec"

AUTOMATIC TANK GAUGE

PATENT NO. 1879805, OTHER PATENTS PENDING

Float and Neg'ator motor actuated — ground reading — automatic tank gauge.

It is gastight and will handle working pressures to 15 p.s.i.g. Equipped with gravity compensator and operation checker.



A feature of this gauge is that it is provided with special pipe brackets to insure alignment and a synthetic rubber expansion joint, which allows 2" vertical movement and ½" horizontal movement of tank roof without stress on tape piping.

Where corrosive vapors are a problem, a liquid seal unit to protect working parts is obtainable at extra cost. Standard liquid seal 8½" H_2O pressure or vacuum. Available for higher pressures upon special order.

Recommended for use with all types of low pressure, fixed roof tanks.

Where remote gauging system is anticipated, "VAREC" Transmitter may be mounted on the cover plate, eliminating cutting into tape piping or gaining access to the float for tape adjustment.

Installation may be made on "tanks in service."

Send for full information—ask for VAREC GAUGING EQUIPMENT Bulletin CP-3007.

"Varec" **VAPOR RECOVERY SYSTEMS COMPANY**
2820 North Alameda Street
Compton, California
Cable address: VAREC COMPTON Calif. (U.S.A.) All Codes

For more information circle **152** on inquiry card.

MANUFACTURERS' NEW LITERATURE

Color-difference Meter. New 6-page Bulletin 156 describes maker's automatic color-difference meter which gives automatic readings and rapid determinations, with null-balance system.—Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.

Circle **493** on inquiry card.

Xenon Arc Lamp. New 4-page issue of "Engelhard Industries Newsletter" (No. 18) describes Xenon arc lamp, presensitized working plate, and photochemical reactor for analysis of photosensitization processes.—Engelhard Industries, 113 Astor St., Newark 5, N. J.

Circle **494** on inquiry card.

Binocular Microscopes. New 20-page Brochure PL 515 describes Kern Swiss-made prismatic binocular microscopes for science and industry; 2-page data sheet describes Super-Stroboscope for analysis of machine milling, etc.—Karl Heitz, Inc., 150 W. 54th St., N. Y., N. Y.

Circle **495** on inquiry card.

Trichometer. New 2-page bulletin describes and illustrates maker's trichrometer, an instrument providing measurement and recording of color characteristics including hue or dominant wavelength.—Kaye Development Co., 79 Prospect St., Stamford, Conn.

Circle **496** on inquiry card.

Vacuum-coating Evaporator. New 4-page Bulletin 2252 describes and illustrates maker's high-vacuum coating evaporator.—American Instrument Co., Inc., Silver Spring, Md.

Circle **497** on inquiry card.

Lens Polishing Machines. New 4-page brochure illustrates and describes maker's four-spindle "Polishmaster" optical polishing machine.—R. Howard Strasbaugh, 10990 Santa Fe Ave., Lynwood, Calif.

Circle **498** on inquiry card.

Collimator. New 4-page brochure describes and pictures maker's collimators for checking flatness of machine beds, for angular checks, etc.—Mitchell Scientific, 70 N. Columbus Ave., Mt. Vernon, N. Y.

Circle **499** on inquiry card.

RADIOACTIVITY

Radioactivity Instruments. New 12-page catalog describes and illustrates maker's instruments for locating uranium and metals.—Precision Radiation Instruments, Inc., 2235 S. La Brea Ave., Los Angeles 16, Calif.

Circle **500** on inquiry card.

Survey Meter. New 4-page bulletin describes and illustrates maker's scintillation-counting survey meters for ultrasensitive detection of radioactive materials.—R. C. Scientific Instrument Co., Inc., 307 Culver Blvd., Playa Del Rey, Calif.

Circle **501** on inquiry card.

Geiger Counter. New 2-page brochure presents features, applications, and specifications of maker's "Model DG-700" geiger counter.—Atomic Center, 489 Fifth Ave., New York 17, N. Y.

Circle **502** on inquiry card.

Rate Meter. New 2-page Bulletin 3021 describes maker's portable instrument for measuring the intensity of X and gamma radiation, for spot checks of radiation sources, for monitoring, and for rate measurements where radioisotopes are handled.—Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle **503** on inquiry card.

Geiger Counter, Converter. New 4-page illustrated brochure describes maker's portable, fully automatic, Geiger counter-scaler; 4-page bulletin presents description, features and technical characteristics of maker's frequency shift converters.—Hoffman Laboratories Inc., 3761 S. Hill St., Los Angeles 7, California.

Circle **504** on inquiry card.

COMPUTING

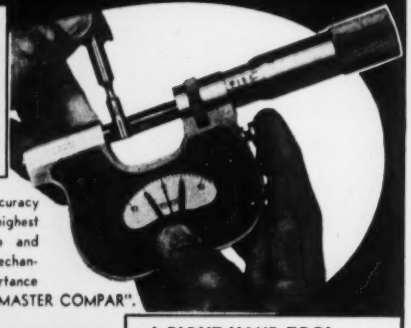
Digital Computer. New 20-page Catalog EDC-3200 describes maker's new electronic digital-computer data-processing systems operated and controlled from a single console. Discusses application in missile problems relating to trajectory coordinates, control, system design, and error analysis.—Consolidated Engng. Corp., 717 North Lake Ave., Pasadena 6, Calif.

Circle **505** on inquiry card.

The "MASTER COMPAR"

INDICATING MICROMETER COMPARATOR

has the VISIBLE feel



No Arguments as to correctness of reading due to "feel". Use it as Comparator, Master Micrometer, Go & No Go Gage. 1" Range reading in 1/10,000"

To attain permanent accuracy at these close limits, highest precision workmanship and exclusive design of mechanism are of Major Importance and ONLY found in "MASTER COMPAR".

0-1" SIZE IN HARDWOOD CASE $95.00

Also Available in LARGER SIZES

A RIGHT HAND TOOL

Release button for movable Anvil on RIGHT Hand side enables you to hold tool the conventional way.

NEW— Resetting to Zero in 5 seconds

Quick adjustable tolerance bands.

Heavy TUNGSTEN CARBIDE Anvils will actually measure Out-of-Roundness, Ovalness & Taper.

Ask for Illustrated Circular — Code GIOFF

Sold thru Tool Supply Houses

Ask for Demonstration

GEO. SCHERR CO., INC.

COMPLETE LINE OF PRECISION INSTRUMENTS

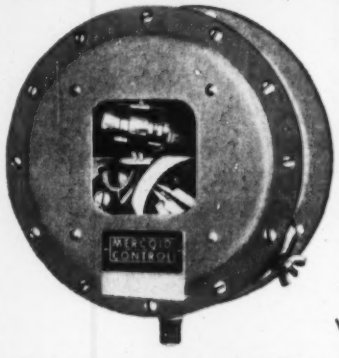
200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **153** on inquiry card.

MERCOID®

PRESSURE CONTROLS

FOR OUTDOOR · SERVICE



Weather Proof
Drip Tight
Semi-dust Tight
Sleet Proof
Splash Proof
Moisture Resistant
Rain Tight
Water Tight

Equipped with Sealed Mercury Contacts

External Adjustments

Visible Calibrated Dial

AVAILABLE IN 17 PRESSURE RANGES FROM

0-30" VAC. TO 300-2500 PSI.

WITH THE SENSITIVITY YOUR APPLICATION REQUIRES

Mercoid weather resistant controls are also available for temperature and liquid level applications.

Write for Bulletin 14PW

THE MERCOID CORPORATION

4201 BELMONT AVE., CHICAGO 41, ILLINOIS, U.S.A.

For more information circle **154** on inquiry card.

Computer Components. New 4-page brochure describes maker's mechanical and electrical components for solving arithmetical problems by mechanical means. Also analog-digital converter for converting digital information to shaft position.—Librascope, Inc., 808 Western Ave., Glendale, Calif.
Circle **506** on inquiry card.

Analog-digital Converter. New two 2-page Catalogs (M415A and 304 947) cover read-and-record heads for magnetic-drum memory systems in digital computers and analog-digital converter for data-handling systems and digital computers.—Librascope, Inc., 1607 Flower St., Glendale, Calif.
Circle **507** on inquiry card.

Angular-position Encoder. New 4-page Data Sheet 10.21-1 describes angular-position encoder combined with maker's strip-chart potentiometer.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.
Circle **508** on inquiry card.

Data-processing Machine. New 2-page bulletin describes maker's decimal data-processing machine "CRC 102-D" for solving a wide range of complex business, industrial, and engineering problems. Is operated on and printed out in decimal form.—National Cash Register Co., 3348 W. El Segundo Blvd., Hawthorne, Calif.
Circle **509** on inquiry card.

Planimeter. New 2-page bulletin describes maker's new "Model 1100" planimeter for measuring large areas. Measures up to 32 inches in width, and unlimited length.—Los Angeles Scientific Instrument Co., 2451 Riverside Drive at Fletcher, L. A. 39, Calif.
Circle **510** on inquiry card.

Tabulating Card File. New 4-page Booklet LBV636 describes and illustrates maker's "Aristocrat" tabulating card file.—Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.
Circle **511** on inquiry card.

TIMING, COUNTING

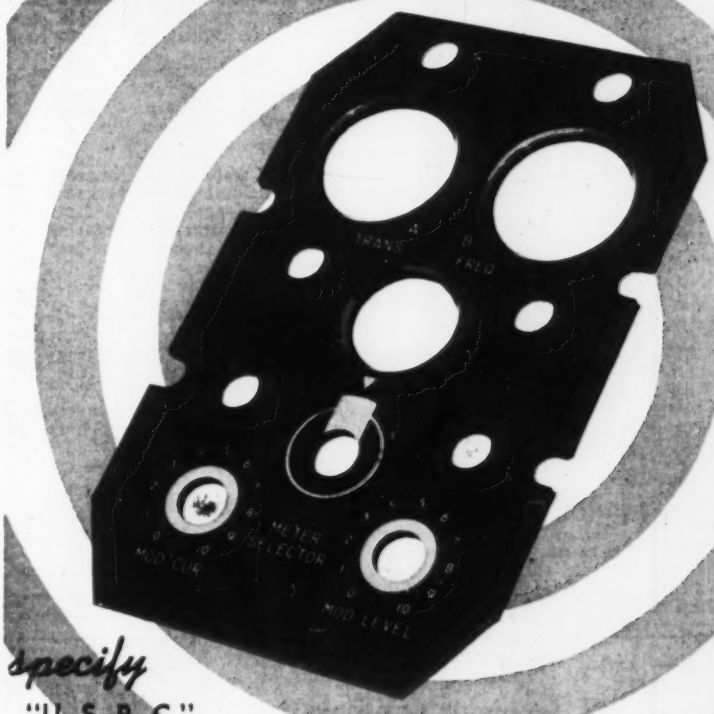
Timing, Counting. New 4-page Bulletin 158-5M 10-49 illustrate and describe maker's printing interval timer, printing counter, and time-recording devices.—Simplex Time Recorder Co., Gardner, Mass.
Circle **512** on inquiry card.

Dial Timer. New 4-page Bulletin N-80 describes maker's "Duo-Set" timer for controlling on-off cycling of two independently-adjusted load circuits in machine and process control.—Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Phila. 44, Pa.
Circle **513** on inquiry card.

Ternary Counter. New 2-page bulletin presents description, specifications and schematic diagram of maker's "Type M3923" plug-in ternary counter.—Walkirt, 145 West Hazel St., Inglewood, Calif.
Circle **514** on inquiry card.

Counting, Timing. New 20-page Catalog A606 describes maker's high-speed electronic counters and scalers used for applications involving length, time, frequency, and quantity measurements. Also precision chronograph

FOR THE MAXIMUM IN
LEGIBILITY



specify
"U. S. R. C."
EDGE-LIGHTED PANELS
meet all requirements of specifications MIL-P-7788 and AN-P-89

Produced by the "Lackon" process, the photographic reproduction method which incorporates the better features of all other panel and dial processing methods. The "Lackon" process combines simplicity, flexibility, adaptability, reproducibility, accuracy and economy.

Regardless of whether your interest is in general appearance, uniformity of lighting, legibility, wear or weather resistance, long life or economy — it will be to your advantage to investigate the best.

May we furnish additional information and make available our engineering and lighting experience?

Write Dept. I-11

UNITED STATES RADIUM CORPORATION
535 Pearl St. New York 7, N. Y.

US RADIUM

For more information circle **155** on inquiry card.

NEW LITERATURE

and timing instruments, frequency measurement counters, etc.—Potter Instrument Co., Inc., Great Neck, N. Y.

Circle **515** on inquiry card.

"Inditron." New 2-page News Release (May '54) describes maker's "Type G1-10 Inditron" used to portray the digits 0—9, one at a time, controlled by an external circuit.—National Union Electric Corp., Hatboro, Pa.

Circle **516** on inquiry card.

Interval Timer. New 1-page bulletin describes maker's interval timer "Type 12 MC" designed to provide a contact closure, adjustable in duration, for automatic machinery requiring controlled time intervals.—G. C. Wilson & Co., Huntington, W. Va.

Circle **517** on inquiry card.

SURFACE

Surface Roughness. New 1-page Bulletin LT93 describes maker's "Type GC" tracer for taking surface-roughness measurements across flat-bottomed grooves of any depth, or on internal or external surface where the part can be mounted approximately horizontal.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Michigan.

Circle **518** on inquiry card.

Surface Roughness. New 4-page bulletin presents description, and diagrams of maker's "Metrisite" position-sensitive transducer that can be used with resistance-bridge measuring instruments.—Graydon Smith Products Corp., 150 Causeway St., Boston, Mass.

Circle **519** on inquiry card.

GAGING

Ionization-transducer Capacitance Gage. New 2-page Instrument Data Sheet 103-1 presents principle, features, and specifications of new comparator micrometer using recently revealed "T-42 Ionization Transducer," and with sensitivity of 1 microinch.—Decker Aviation Corp., 1361 Frankford Ave., Philadelphia, Pa.

Circle **520** on inquiry card.

Optical Comparators. New 32-page illustrated Catalog 402-B presents description and applications of maker's optical comparators and attachments.—Jones & Lamson Machine Co., Springfield, Vt.

Circle **521** on inquiry card.

Self-centering Bore Gages. New 2-page bulletin describes and illustrates "Mahr" self-centering bore gages for determining simultaneously the maximum and minimum measurement along axis. Can check cylinders and bores of all kinds.—Geo. Scherr Co., Inc., 200 Lafayette St., N. Y. 12, N. Y.

Circle **522** on inquiry card.

Pocket Comparator. New 8-page brochure describes "Pee-Gee" pocket comparator, a precision optical measuring instrument for determining small dimensions, diameters of small holes, sizes of fine threads and wires, number of screw threads per inch, etc.—National Tool Co., 11299 Madison Ave., Cleveland 2, Ohio.

Circle **523** on inquiry card.

Beta-ray Gage. New 4-page issue of "Nucleonics Views" (Vol. 2, No. 4) describes maker's "AccuRay" reflection gage which is mounted without requiring extensive alterations, and compensates automatically for environmental changes.—Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus, Ohio.

Circle **524** on inquiry card.

Micrometer. New 4-page booklet describes maker's "Microfix" mechanical micrometer which reads to 0-0001 inch.—Karl A. Neise, 404 Fourth Ave., N. Y. 16, N. Y.

Circle **525** on inquiry card.

TESTING

Paper, Plastic Testing Instruments. New 24-page Bulletin 1400 describes procedures for testing paper stocks, textiles, leather, plastics and other sheet materials. Includes procedures for stiffness, smoothness, porosity, and softness.—W. & L. E. Gurley, Troy, N. Y.

Circle **526** on inquiry card.

Universal Testers, Dynamometers. New 6-page Bulletin 19-F describes maker's universal tester, mechanical pressure gage, and dynamometer used for tensile or static-load testing.—W. C. Dillon & Co., Inc., 14606 Keswick St., Van Nuys 3, Calif.

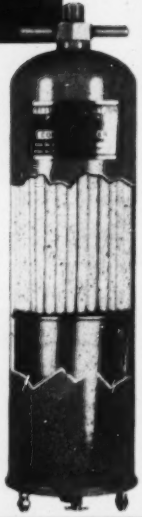
Circle **527** on inquiry card.

Rubber Hardness Tester. New 2-page circular and calibration chart

HANKISON PRODUCTS CUT MAINTENANCE COST.

YOU MUST... Condense and filter ...if you want "INSTRUMENT-QUALITY" Compressed Air

HANKISON Condensifilter



Sets years-ahead filtering standards. When your problem involves Clean, Dry, Air to obtain more efficient, dependable instrument operation, the Hankison Condensifilter offers you a practical low cost solution.

Hankison Condensifilters give greater overall efficiency through these engineering extras -

- Twin Action Principle, that both filters and dehydrates.
- "O" ring seal construction.
- Low maintenance cost.

See why maintenance men are specifying Condensifilters. A qualified engineer is available to consult with you on all compressed air problems.

SEND FOR BULLETIN

HANKISON CORPORATION

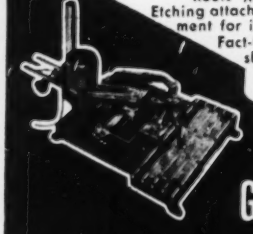
352 BILTMORE BLDG. 951 BANKSVILLE RD. PGH. 16, PA.

For more information circle **156** on inquiry card.

Versatility with a GREEN ENGRAVER

ENGRAVES PANELS DIALS PLATES

Mark your own symbols, numbers, lettering, on your small parts, tools, identification and name plates . . easily, simply, quickly . . tracing from a master with the GREEN ENGRAVER. Widely used in electronic and plastic fields, in machine tool shops and wherever permanent marking is needed. The GREEN ENGRAVER engraves equally well on metals, plastic, wood, hard rubber and glass. Routs Models Profiles Engraves Etching attachment and other special equipment for industrial uses are available. Fact-filled folder on request showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.



GREEN INSTRUMENT COMPANY 883 PUTNAM AVE. CAMBRIDGE MASS.

For more information circle **157** on inquiry card.

presents "Pandux" rubber-hardness tester and table of conversions for latex foam rubbers, sponge rubbers, and rubber-like plastic sponge.—Pacific Transducer Corp., 11836 W. Pico Blvd., L. A. 64, Calif.

Circle **528** on inquiry card.

Cable Checker. New 4-page illustrated Bulletin LP-3503 5C-4-54 and 4-page insert list features and specifications of maker's automatic cable checker.—Link Aviation Inc., Binghamton, N. Y.

Circle **529** on inquiry card.

Cable Inspector. New 4-page Bulletin C1-100 presents maker's "Hi-Speed" cable inspector used to check insulation resistance of multiconductor cables.—Panascan Co., 7401 N. Hamlin Ave., Skokie, Ill.

Circle **530** on inquiry card.

Flexibility Tester. New 3-page illustrated Bulletin 153 describes maker's flexibility tester for organic finishes.—Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **531** on inquiry card.

Hardness Tester. New 4-page Bulletin RH-12-54 describes maker's portable hardness testers for production testing of crankshafts, cylinder blocks, assemblies and similar pieces.—Riehle Testing Machines Div. of American Machine and Metals, Inc., E. Moline, Ill.

Circle **532** on inquiry card.

Rubber Testing. New 8-page issue of "Neoprene Notebook 60" features article on rubber industry tests and what results mean to engineers and designers of rubber parts. Also articles on industrial uses of rubber.—Rubber Chemicals Div., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Circle **533** on inquiry card.

Compression Testers. New 2-page Bulletin LT-500 describes maker's concrete compression testing machine "Model LT-500" laboratory equipment designed and built to operate in accordance with A.S.T.M. specifications.—Forney's, Inc., 209 Elm St., New Castle, Pa.

Circle **534** on inquiry card.

Holiday Detector. Three new 2-page bulletins picture and describe maker's "Models DS-3 and H-2" all-purpose pipeline detectors which provide constant inspection voltage on any pipe size under all operating conditions.—Tinker & Rasor, P. O. Box 281, San Gabriel, Calif.

Circle **535** on inquiry card.

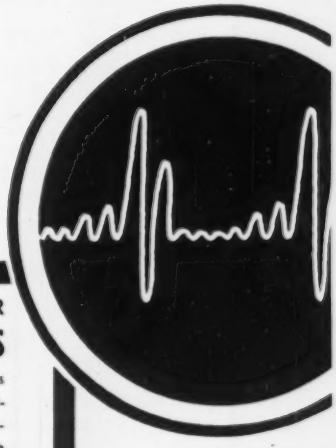
ANALYTICAL

Analytical Instruments. New 12-page Catalog CEC-1302A describes maker's analytical, isotope-ratio, dual-purpose and process-monitoring mass spectrometers. Also high-vacuum leak detectors for analyses in petroleum, petro-chemical, processing, and medical fields.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

Circle **536** on inquiry card.

Infrared Analyzer. New 4-page Data Sheet 10-16-7b describes and illustrates selective infrared plant-stream analyzer.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **537** on inquiry card.



SPECIAL OPPORTUNITIES FOR

ELECTRONIC ENGINEERS

Convair in beautiful, sunshiny San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in missiles, engineering research and electronics development. Positions open in these specialized fields:

Microwave Antennae	Dynamics Testing
Microwave Components	Telemetering
Electronic Packaging	Servomechanisms
Mathematical Physics	Electron Tubes
Electronic Components	Radome Design
Electronic Systems	Digital Computers
Applied Mathematics	Test Equipment
Transmitters & Receivers	Miniature Circuits

Generous travel allowances to those accepted. For free brochure, write Mr. H. T. Brooks, Engineering Dept. I-11.

CONVAIR

IN BEAUTIFUL

SAN DIEGO

Division of General Dynamics

3302 PACIFIC HIWAY

SAN DIEGO 12, CALIFORNIA

NOW YOU CAN ORDER
PRECISION RECORDING CHARTS MORE EFFICIENTLY!

- Any of 8000 different roll and dial charts available from one source.

Here's a practical service used by over 2000 large and small instrument users. Whatever the makes of instruments in their processes, they receive all their chart needs from Technical.

Your company, too, can experience the same economies in ordering, delivery, stocking and chart costs . . . by ordering from Technical. Chart precision and high quality result from Technical's exclusive specialization in chart making.

Technical provides "Special" Charts for any new instrument or chart idea you have. Complete catalog of services and charts available . . . write today.

TECHNICAL CHARTS INCORPORATED

188 VAN RENSSELAER ST. BUFFALO 10, N. Y.

Nationally Represented by TECHNICAL SALES CORPORATION, 16599 Meyers Road Detroit 35, Michigan

For more information circle **158** on inquiry card.

THE NEW

PYRO

Surface Pyrometer

●

PYROMETER INSTRUMENT COMPANY

Bergenfield 4, New Jersey

●

The NEW PYRO Surface Pyrometer has been designed to meet all plant and laboratory surface and sub-surface temperature measurements. Has large selection of thermocouples and extension arms — all interchangeable without adjustment. Quick acting, accurate, light-weight and rugged. It features a large 4¾" direct reading scale, automatic cold end junction compensator and a shielded steel housing—all combined to offer the highest precision, accuracy, dependability and durability. Available in five standard temperature ranges from 0-300°F to 0-1200°F.

Literature also available FREE on PYRO Optical, Indicating, Radiation and Immersion Pyrometers.

Ask for Catalog No. 168 for full details.

For more information circle **159** on inquiry card.

TRINITY
DOUBLE-BORE THERMOWELLS

- ***Minimize the factors of error in Temperature Instrument Test Procedures***
- ***Permit accurate test without removing detecting element from well***
- ***Eliminate the use of separate test wells***
- ***Reduce the cost of Test Procedure***

Write for Bulletin 541

Two holes are provided in each well:
The Primary hole accommodates the detecting element of a permanently installed Temperature instrument
The Secondary hole accommodates a #20 gauge test thermocouple

TRINITY EQUIPMENT CORPORATION

494 Westfield Ave., East • Roselle Park, New Jersey

For more information circle **160** on inquiry card.

NEW LITERATURE

H_2S Sampler. New 4-page booklet describes maker's sampler for measurement of low concentration of hydrogen sulfide.—Research Appliance Co., Box 463 West View Rd., Pittsburgh 9, Pa.

Circle **538** on inquiry card.

pH Meter. New 6-page folder describes and illustrates maker's new analytical pocket pH meter with scales from 2 to 12 pH.—Analytical Measurements, Inc., 585 Main St., Chatham, N. J.

Circle **539** on inquiry card.

pH Meter. New 2-page bulletin presents maker's pocket pH meter and probe unit for simple continuous pH control.—Analytical Measurements, Inc., Chatham, N. J.

Circle **540** on inquiry card.

Soil Analysis. Three new 2-page brochures illustrate maker's soil hydrometers, size determination apparatus, scales and balances, desiccators, wash bottles, aluminum beakers, etc. —Soiltest Inc., 4520 W. North Ave., Chicago 39, Ill.

Circle **541** on inquiry card.

Agricultural Chemical Analyses. New 4-page Bulletin 4 is price list for analyses, sampling and inspection of agricultural chemicals and products.—Research and Development Laboratories, 1138 E. North Ave., Baltimore 2, Md.

Circle **542** on inquiry card.

Analytical Balances. New illustrated 8-page Bulletin FS-207 presents theory and operation of maker's "Gramatic" and "Micro Gram-atic" single-pan balances.—Fisher Scientific, 717 Forbes St., Pittsburgh 19, Pa.

Circle **543** on inquiry card.

Viscometers. New 4-page Bulletin 15 describes and illustrates maker's routine, opaque, and semi-micro viscometers.—Cannon Instrument Co., Box 812, State College, Pa.

Circle **544** on inquiry card.

LAB APPARATUS

Interference Microscopes. New 8-page Bulletin 818 describes and illustrates maker's microscopes for surface measurements, visual or photographic, applied to crystal studies, thermal-expansion measurements, biological specimens, membranes.—Farrand Optical Co., Inc., Bronx Blvd. & E. 238 St., N. Y. 70, N. Y.

Circle **545** on inquiry card.

Lab Aids. New 6-page brochure presents maker's "Sequex" labels which stick to flat surfaces; micro beakers for weighing small quantities of materials for analysis; non-drying immersion oils for microscopy, etc.—Cargille Scientific, Inc., 117 Liberty St., N. Y. 6, N. Y.

Circle **546** on inquiry card.

Lab Supplies. Three new 6-page bulletins describe maker's silicone defoamer for laboratory, and pilot plant, Labelon plastic tape, and Ohaus micrometer poise.—Palo Lab. Supplies, 81 Reade St., New York 7, N. Y.

Circle **547** on inquiry card.

Lab Equipment. New 4-page brochure presents maker's new leak detector which detects a flow from atmosphere into a vacuum of less than 0.00001 std. cc/hr., and evaporating unit which provides a large working surface and vacuum bell volume.—Vacuum-Electronic Engrg. Co., 86 Denton Ave., New Hyde Park, L. I., N. Y.

Circle **548** on inquiry card.

Constant-temperature Ovens. New 36-page Catalog 331A describes and illustrates maker's ovens, cabinets, and incubators which are double-walled, all steel, and electrically welded.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **549** on inquiry card.

Film Applicator. New 4-page Bulletin 155 describes and illustrates maker's instrument for laying down wet films of any desired thickness for comparative analyses relating to color, opacity, weatherproofness, durability etc.—Gardner Lab., Inc., Bethesda 14, Md.

Circle **550** on inquiry card.

Lab Apparatus. New 20-page issue of "Burrell Announcer" (No. 54-9-55) describes maker's electrothermal heating tapes for heating vessels and pipes; wedge interference filter, a vest pocket spectroscope for scientist interested in color phenomena; high-speed magnetic mercury cathode, etc. —Burrell Corp., 2223 Fifth Ave., Pgh. 19, Pa.

Circle **551** on inquiry card.

Lab Apparatus. New three 2-page bulletins describe maker's castor gelometer for automatic determination of gelation time of polyesters or phenolics; colorimeter-spectrophotometer with 41 calibrations; and Alconox, an industrial detergent, degreaser, and wetting agent.—Burrell Corp., 2223 Fifth Ave., Pgh. 19, Pa.

Circle **552** on inquiry card.

Water-bath Shaker. New 1-page bulletin describes maker's new reciprocating constant-temperature bath-shaker for continuous operation.—New Brunswick Scientific Co., 10 Hiram St., New Brunswick, N. J.

Circle **553** on inquiry card.

Vial Filler. New 4-page illustrated brochure lists features and advantages of maker's electronically controlled "Filamatic" aseptic vial filler.—National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.

Circle **554** on inquiry card.

Stirrer. New 2-page Bulletin 490 VIII 54 presents features and diagrams of maker's 3-speed stirrer and accessories.—Eberbach Corp., Ann Arbor, Mich.

Circle **555** on inquiry card.

Ovens, Incubators. New 16-page catalog on maker's gravity and mechanical convection laboratory ovens and sterilizers.—Modern Lab. Equipment Co., Inc., 1809-11 First Ave., N. Y. 28, N. Y.

Circle **556** on inquiry card.

Controlled Stirrer. New 2-page bulletin describes maker's "3650" adjustable-speed stirrer with series-wound ball-bearing gear-head motor.—Ace Glass, Inc., Vineland, N. J.

Circle **557** on inquiry card.

Something new is always happening at AIRPAX

- *Still smaller and much lighter than ever before!*
- *Rugged, reliable and shockproof!*

A175 MIDGET 60 cycle CHOPPER

Life tests on our recording racks tell us this unit has exceptionally good life and reliability.

- Rated 25 to 110 cycles
- Phase 21° at 60 cycles
- SPDT break-before-make
- Dwell time 170°
- Life well over 1000 hours
- Very low residual noise

FITS 7 PIN MINIATURE SOCKET

AIRPAX PRODUCTS COMPANY — DESIGNERS — ENGINEERS

MIDDLE RIVER — BALTIMORE 20, MD

For more information circle **161** on inquiry card.

"As a comprehensive source book on instrument circuitry, this one will be hard to beat" . . . *Radio & Television News* (Sept. 1953)

ELECTRONIC CIRCUITRY FOR INSTRUMENTS & EQUIPMENT

By MILTON H. ARONSON

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $..... for ..... copies of Aronson's ELECTRONIC CIRCUITRY BOOK at $4.00 each, postpaid.

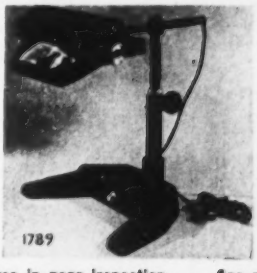
Name .....
Address .....
City .....

Answers to I.Q. Quiz on page 1824

1.—a	13.—a	25.—c
2.—d	14.—c	26.—b
3.—d	15.—b	27.—b
4.—b	16.—c	28.—b
5.—d	17.—b	29.—c
6.—c	18.—c	30.—a
7.—a	19.—d	31.—b
8.—d	20.—a	32.—b
9.—a	21.—a	33.—a
10.—c	22.—a	34.—d
11.—c	23.—a	35.—b
12.—d	24.—c	

NOW . . . IT'S NEW The only *rectangular illuminated* inspection lamp that frees both hands . . . enables use of both eyes . . .

SPEEDS UP INSPECTION!



For use in gear inspection . . . fine parts inspection, printing, engravings, fine assembly work, fine paintings, fine machine work, lathe work.

Check These Exclusive Features

- Large clear field—6½" x 2½" Plano convex
- Attachments without base for use in lathe work available.
- Tilts to any angle
- Slides forward
- Relieves eye strain in close production inspection
- Lens focal length of—6 inches
- Heavy aluminum cast parts
- Precision ground polished lens
- 2 fluorescent 12-watt lamps

For complete information and illustrated bulletin, write:

ESCO PRODUCTS

1428 WILLOW AVENUE, HOBOKEN, N. J.

For more information circle **162** on inquiry card.

Weighing Systems

by Pneumatic Force Balance

PROVIDE AUTOMATION FOR THE CONTINUOUS OR BATCH PROCESS.

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

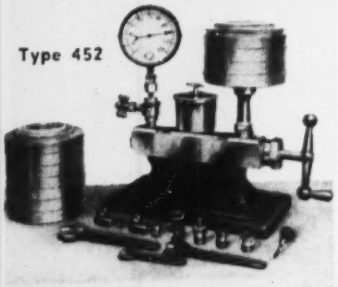
WRITE FOR CATALOG

JOHN R. MONSELL COMPANY
Pitman, N. J.

For more information circle **163** on inquiry card.

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in 14 ranges, to 10,000 lbs. maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave., Brooklyn, N.Y.

For more information circle **164** on inquiry card.

JORDAN

HEALTH AREA MONITOR

Measuring continuously and intermittently . . .

GAMMA BETA NEUTRON

Models RAMS-1 and RAMS-2, are

ADAPTABLE
RELIABLE
INEXPENSIVE

WRITE FOR DATA FILE 30

Jordan Electronic Mfg. Co., Inc.
119 East Union Street • Pasadena 1, California

For more information circle **165** on inquiry card.

NEW LITERATURE

Lab Apparatus. New 16-page issue of "Apparatus Digest", describes and illustrates apparatus, instruments including needle valves, ultraviolet light; flexible wrap-around heating tapes; dial stop clocks; etc.—A. Daigger & Co., Kinzie at Wells, Chicago 10, Ill.
Circle **558** on inquiry card.

MICROWAVE

X-band Universal Test Set. New 4-page brochure describes maker's "Model W-109" test set which contains power monitor, spectrum analyzer, wavemeter, and signal generator.—Kearfott Co., Inc., Van Nuys, Calif.
Circle **559** on inquiry card.

Test Equipment. RF Instruments. New 2-page bulletin describes maker's standing wave amplifier "Model 601" and "Klystron" power supply.—Cubic Corp., 2841 Canon St., San Diego 6, Calif.
Circle **560** on inquiry card.

Spectrum Analyzer. New 6-page brochure describes and illustrates maker's "SA25" microwave spectrum analyzer for microwave radar and control equipment.—Vectron, Inc., 400 Main St., Waltham 54, Mass.
Circle **561** on inquiry card.

Microwave Analyzer. Five new 2-page data sheets describes maker's microwave tuning unit covering upper half of "L" band and part of lower "S" band on fundamentals.—Vectron, Inc., 400 Main St., Waltham 54, Mass.
Circle **562** on inquiry card.

POWER SUPPLIES

Constant-voltage Transformers. New 20-page Bulletin CV-210 presents design, theory, and operation of maker's constant-voltage transformers.—Sola Electric Co., 4633 West 16th St., Chicago 50, Ill.
Circle **563** on inquiry card.

Line-voltage Regulator. New 8-page issue of "The Experimenter" (Vol. 22 No. 2) features articles describing maker's high-speed, automatic line-voltage regulator.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Circle **564** on inquiry card.

Voltage Regulator. New 4-page Bulletin T-8400 describes and illustrates maker's "RX400" all static voltage regulator for 400-cycle machines.—Inet Div. of Leach Corp., 4441 Santa Fe Ave., Los Angeles 58, Calif.
Circle **565** on inquiry card.

Power Supply. New 2-page bulletin describes maker's variable-frequency power supply for testing airborne electronic equipment and electrical systems; for powering vibration shakers; and for controlling processing equipment and synchronous motors.—Vectron, Inc., 400 Main St., Waltham 54, Mass.
Circle **566** on inquiry card.

Voltage Regulators. New 12-page Booklet 3090 describes "Type JS 1/1 and JSG 1/1" regulators for small and medium-size a-c. generators. Booklet 3095 covers "Type JB 1/1" regulator

for medium and medium-large a-c. generators.—Brown Boveri, 19 Rector St., N. Y. 6, N. Y.

Circle **567** on inquiry card.

Batteries. New 16-page issue of "Storage Battery Power" (Vol. 24, No. 5) features articles on highly developed industrial trucking system based on electric battery power.—Thomas A. Edison, Inc., 21 West St., N. Y. 6, N. Y.

Circle **568** on inquiry card.

ELECTRICAL ELECTRONIC INSTRUMENTS

Test Instruments. New 16-page Form 5401 presents maker's test instruments, including universal bridge, power supplies, "Q" indicator, "Type 1020-B" megohmmeter, etc.—Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn (Ridgewood) 27, N. Y.

Circle **569** on inquiry card.

Complex Plane Analyzer. New 4-page bulletin "Laboratory Report #11" describes complex plane analyzer, its methods of use and the relationship to closed-loop systems and root locus.—Technology Instrument Corp., 531 Main St., Acton, Mass.

Circle **570** on inquiry card.

Oscillograph. New 16-page issue of "The Oscillographer" (Vol. 15, No. 1) discusses cathode-ray tube and how it is made.—Allen B. Du Mont Labs., Inc., Instrument Div., 760 Bloomfield Ave., Clifton, N. J.

Circle **571** on inquiry card.

Oscilloscopes. New 4-page bulletin describes and illustrates maker's large-screen rectangular-tube oscilloscope used for telemetering, production tests, waveform analysis, etc.—Electromec, Inc., 3200 N. San Fernando Blvd., Burbank, Calif.

Circle **572** on inquiry card.

Large-screen Oscilloscope. New 4-page brochure presents applications and specifications of maker's direct-view, large-screen, oscilloscope.—Technomatic Instrument Co., 11368 W. Olympic Blvd., West Los Angeles 64, Calif.

Circle **573** on inquiry card.

Synchroscope. New 4-page brochure describes and illustrates maker's "Model C-04" extended-range synchroscope with a positive pulse of 250 volts (minimum) from an impedance of approximately 300 ohms.—TLG Electric Corp., 31 W. 27th St., N. Y. 1, N. Y.

Circle **574** on inquiry card.

Oscilloscope. New 12-page Catalog form 1053 listing maker's push-pull oscilloscope kit "Model 425-K and oscilloscope voltage calibrator kit. 2-page data sheet describes flyback transformer, yoke tester, and multi-signal tracer.—Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.

Circle **575** on inquiry card.

Microoscillograph. New 4-page bulletin presents description, specifications and photograph of maker's "Model 2" high-speed microoscillograph.—Central Research Laboratories, Inc., Red Wing, Minn.

Circle **576** on inquiry card.

Sorry . . .
A. W. HAYDON CO.
can't help you.

Only instruction, practice, and patience can improve your score!

But . . . if your problem is PRECISION TIMING

you may save time, trouble and money by investigating what our timing engineers have done for others. Our A.C. and D.C. achievements may already include the solution of your most complex problem. Why not find out?

Send for latest catalog manual

The A.W. HAYDON COMPANY
228 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electrical Timing Devices

For more information circle **166** on inquiry card.

Servotherm Pyrometers and Servofrax* Optics provide industry with practical tools for remote temperature measurement.*

Through the use of Servotherm Industrial Pyrometers and Servofrax Infrared Optics it is possible to obtain indications of temperature without physically contacting the object in any way. Radiation pyrometry has been completely developed using the rapid-responding thermistor bolometer. Extremely high sensitivity coupled with system time constants in the order of milli-seconds makes it possible to measure temperature differences or map the temperature distribution of moving objects. The field of view can be made extremely small, if necessary, in order to view objects at considerable distances. For descriptive specifications write Dept. I-11.

SERVO
CORPORATION OF AMERICA
New Hyde Park, New York

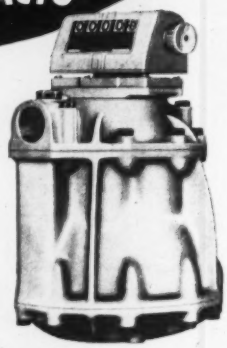
SC 124

For more information circle **167** on inquiry card.

YOU NAME THE LIQUID . . .

BOWSER

WILL MEASURE IT WITH XACTO



. . . "the meter that changed chemical processing habits"!

For over a quarter century Bowser Xacto meters have brought to the chemical industry an entirely new way to measure liquids accurately and dependably.

Wherever accurate measurement is essential to assure uniformity of product and control costs . . . there you will usually find Bowser Xacto meters on the job.

Today XACTO meters are handling these and 638 other liquids. . . .

Acetic Anhydride	Amyl Acetate	Carbolic Acid	Iso-Propyl Acetate
Alum Solution	Anhydrous Ammonia	Cellosolve Acetate	Lactic Acid
Ammonium Chloride	Aqueous Ammonia	Copper Nitrate	Napthenic Acid
Ammonium Nitrate	Arsenic Acid	Copper Sulphate	Resin Alkyd
Ammonium Phosphate	Butyl Acetate	Cresol	Stearic Acid
Ammonium Sulphate	Calcium Bisulphite	Cresylic Acid	Tannic Acid

MAY WE SEND COMPLETE DATA?

BOWSER, INC., 1367 Creighton Avenue, Fort Wayne 2, Ind.

Regional Offices • Atlanta • Chicago • Cleveland • Dallas • Kansas City • New York • San Francisco • Washington, D. C. • Hamilton, Ont.

For more information circle **168** on inquiry card.

CHECK ALL TENSIONS

with the new Trigger

SAXL TENSION METER

Quickly—Correctly In Small Space

METERS FOR WIRES YARNS, LASTEX, etc.

TENSITRON, INC.
HARVARD, MASSACHUSETTS

Some territories still open for qualified representatives

For more information circle **169** on inquiry card.

PREIS Model 2D-4 ENGRAVING MACHINE

"A medium sized machine that does the work of a larger one"

Unlimited ratios from 1 to 1 to infinity.

Engraves 30" wide panels by any length.

No engraving shop is complete without a *PANTO ENGRAVER. Several models available for 2 and 3 Dimensional Engraving.

Write for NEW color folder.

PANTO *TRADE MARK Reg. U.S. Pat. Off.

H. P. PREIS Engraving Machine Co.
661 U. S. Highway 22 Hillside, N. J.

For more information circle **170** on inquiry card.

NEW LITERATURE

CR Tube Tester. New 2-page Bulletin CRT 754H describes and illustrates maker's "Model 590" TV picture-tube tester which checks a TV picture tube for brilliance, emission, shorts, gas, grid control, leakage, condition of phosphor, etc.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle **577** on inquiry card.

Sound-level Meter. New 8-page issue of the "Experimenter" (Vol. XXIX, No. 4) describes "Massa Model M-141B" standard microphone that can be used for measuring sound levels in engine test cells and near high-powered airplanes, and for measuring blast pressures of gunfire and other explosions.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **578** on inquiry card.

Decade Amplifier. New 2-page bulletin describes maker's d-c. decade amplifier "Model 103" for recorder or oscilloscope pre-amplification, strain gage applications, servo system design and testing.—Kay Lab., 1090 Morena Blvd., San Diego 10, Calif.

Circle **579** on inquiry card.

Indicating Amplifier. New 2-page Bulletin 1A describes and illustrates maker's d-c. indicating amplifier "Type 2HLA-3" designed as a polarity-sensing microvoltmeter for direct measurement of low-level d-c. signals.—Doelcam Corp., 1400 Soldiers Field Rd., Boston, Mass.

Circle **580** on inquiry card.

Current Test Set. New 4-page illustrated issue of "Electrical Measurements" (Vol. 21, No. 8) features article on universal alternating-current test sets.—Sensitive Research Instrument Corp., Mount Vernon, N. Y.

Circle **581** on inquiry card.

Reference Standard Indicator. New 4-page bulletin describes "Model C Poly-Ranger," a long scale milliammeter, ammeter, voltmeter.—Sensitive Research Instrument Corp., Mount Vernon, N. Y.

Circle **582** on inquiry card.

Galvanometer Indicator. New 4-page brochure describes and illustrates maker's switchboard indicator using frictionless galvanometer and taut-suspension galvanometer with a deflection sensitivity as high as two inches per millivolt.—Charles Engelhard, Inc., 850 Passaic Ave., E. Newark, N. J.

Circle **583** on inquiry card.

Relay Amplifier. New 8-page bulletin describes maker's relay amplifier that eliminates use of intermediate relays which have high sensitivity and low capacity contacts.—Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif.

Circle **584** on inquiry card.

Digital VTVM. New 2-page illustrated bulletin presents features and specifications of maker's "Model 615" digital, vacuum-tube volt meter.—Hycon Mfg. Co., 2961 East Colorado St., Pasadena 8, Calif.

Circle **585** on inquiry card.

Waystation Subset. New 2-page Circular 1810 pictures and describes maker's new waystation subsets for waystation train dispatching telephones.—Automatic Electric Sales Corp., 1033 West Van Buren St., Chicago 7, Ill.

Circle **586** on inquiry card.

Phase Meter. New 2-page bulletin covers applications, operation principle, features and specifications of maker's "Model 200A" phase meter.—Industrial Test Equipment Co., 55 East 11 St., New York 3, N. Y.

Circle **587** on inquiry card.

Ultrasonic Generator. New 2-page Bulletins 1 and 2 present maker's "Model 50" series liquid-load ultrasonic generator; 4-page illustrated brochure covers products, services, facilities and personnel.—McKenna Laboratories, 2503 Main St., Santa Monica, Calif.

Circle **588** on inquiry card.

Electronic Instruments. New 60-page catalog describes and illustrates distributor's electronic instruments, including oscillographs, power supplies, television instruments, spectrum analyzer, and decade scalers.—M. E. Gerry & Co. Inc., 230 Bayard Rd., Upper Darby, Pa.

Circle **589** on inquiry card.

Frequency Meter. New 2-page bulletin describes and illustrates maker's "Frequency Meter TS-175 A/U" for determining or setting frequency of transmitters operating on CW and on MCW with noise, voice, tone, or other modulation.—Colortone Electronics, Inc., 238 William St., N. Y., N. Y.

Circle **590** on inquiry card.

Panel Meter. New 2-page engineering data sheet on maker's "Model 150" sealed panel meter, a waterproof, high-precision miniature panel instrument for easy one hole mounting.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **591** on inquiry card.

Compass System. New 8-page Catalog MC-101 presents application, operation, installation, specifications and block diagram of maker's "MC-101" compass system.—Collins Radio Co., Cedar Rapids, Iowa.

Circle **592** on inquiry card.

ELECTRON TUBES

Tube Characteristics Manual. New 200-page tube characteristics manual contains data on 600 receiving tubes, 110 premium types, 170 cathode-ray tubes, 85 diodes plus tube base diagrams, color codes, dial lamps, and numbering codes.—Tung-Sol Electric Inc., Newark 4, N. J.

Circle **593** on inquiry card.

Miniature Electron Tubes. New 12-page CBS-Hytron Guide lists all miniature tubes, includes pertinent data for 329 types, 135 basing diagrams, numerous operating conditions and indicates larger prototypes.—CBS-Hytron, Danvers, Mass.

Circle **594** on inquiry card.

Power Triodes. New technical data sheets describe maker's low-mu, high-

ANALOG-DIGITAL CONVERTER

NO AMBIGUITY
FAST RESPONSE

A shaft position to digital conversion component for data handling systems and digital computers. Multi-brush pick-offs eliminate ambiguity. Adapted to be used in digital to analog conversion systems and closed loop systems. Standard unit handles 13 digits; 7, 17, and 19 digit models also available. Multi-channel converters designed to be time-shared with one scan network. Custom models may be ordered to your specifications.

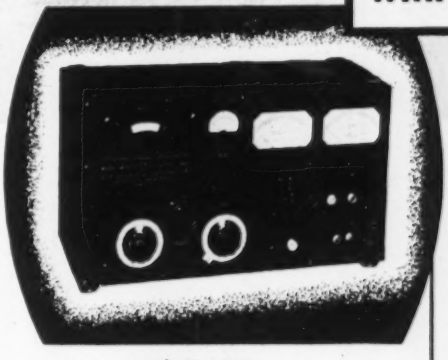
SPECIFICATIONS:
Dia. 2 in. Wt. 8 oz.
Length: 2-3/4 to 5", according to model
Torque: Under 0.2 oz. in.
Meets applicable military specifications

Write for catalog information.

Computers and Controls
LIBRASCOPE
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION
LIBRASCOPE, INCORPORATED
808 WESTERN AVE. • GLENDALE • CALIF.

For more information circle **171** on inquiry card.

UHF Standard Signal Generator with Low Hum Level



MODEL 84-TV

FEATURES:
- DC operation of oscillator tube filament.
- Wide continuous frequency coverage.
- Frequency calibration accurate to ± 0.5%.
- Output dial calibrated in microvolts.
- Negligible stray field and leakage.
- Special design mutual inductance type attenuator.
- Low harmonic content.
- Low residual hum modulation.

SPECIFICATIONS:

Frequency Range: 300 to 1000 Mc.
Frequency accuracy ± 0.5%.

Output: 0.1 uv to 1.0 v across a 50-ohm load.

Modulation: 0 to 30% from an internal 1000-cycle oscillator. External modulation from 50 to 20,000 cys. Residual hum modulation less than 0.5%.

Power Supply: 105 to 125 volts, 60 cycles, 120 watts.

Leakage: Negligible.

USES:
The versatility of this instrument makes it adaptable to many applications within its frequency range; for driving slotted lines and other impedance measuring devices; for measuring the characteristics of UHF filters, traps, antennas, matching networks and other devices.

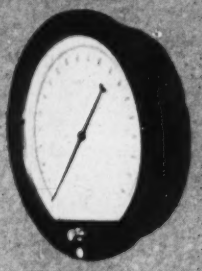
Laboratory Standards
MEASUREMENTS CORPORATION
BOONTON • NEW JERSEY

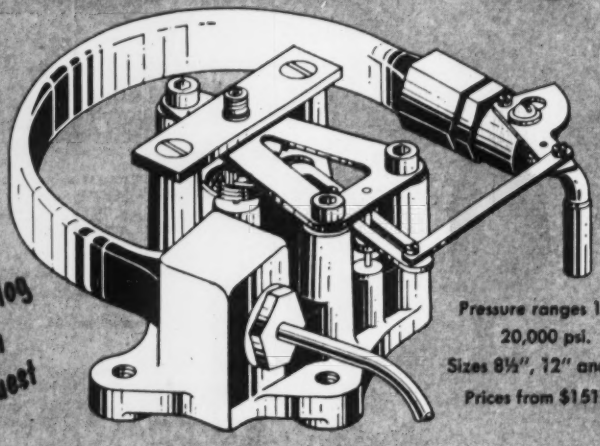
For more information circle **172** on inquiry card.

HEISE GAUGES

The Standard of the World

To meet the need for scientifically accurate high pressure gauges Heise engineers have developed the instrument now used as a calibrating standard throughout the world.





Catalog on Request

Pressure ranges 15 to 20,000 psi.
Sizes 8½", 12" and 16"
Prices from $151.60

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **173** on inquiry card.

High Precision Optical Components Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane Mirrors

•

Plane Parallel Plates

•

Schlieren Systems

•

Wind Tunnel Optics

•

Lenses & Prisms of Glass Natural or Synthetic Crystals

•

Complete Optical and Mechanical Instruments

•

Made to Specifications

•

High Vacuum Coating

•

John Unertl Optical Co.
3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **174** on inquiry card.

MARTINDALE

DEMAGNETIZER MODEL D-3

This tool quickly and easily removes magnetism from cutting tools such as cutters, drills, saws, etc., and thus keeps them free from chips and metal-slivers that reduce production. Cuts cost of tool maintenance.

Write for 64-Page Catalog No. 29 describing many products for Industrial Maintenance, Safety and Production.

MARTINDALE ELECTRIC CO.
1360 Hird Avenue, Cleveland 7, Ohio

For more information circle **175** on inquiry card.

NEW LITERATURE

perveance power triodes.—Chatham Electronics Corp., 630 Mt. Pleasant Ave., Livingston, N. J.

Circle **595** on inquiry card.

Gas Phototube. New 3-page Booklet 6405/1640 describes and illustrates maker's gas phototube for use in industrial applications critical as to microphonics and sensitivity gradient.—Radio Corporation of America, Harrison, N. J.

Circle **596** on inquiry card.

Traveling-wave Tube. New 2-page bulletin describes maker's new medium-power traveling-wave amplifier tube.—Huggins Labs., Inc., 711 Hamilton Ave., Menlo Park, Calif.

Circle **597** on inquiry card.

RESISTORS, RHEOSTATS

Resistors. New 6-page Leaflet C-1024 presents features of maker's "CE 100" hermetically-sealed resistors; 12-page Catalog 14-R pictures and describes non-inductive fixed wire-wound resistors; 8-page Bulletin C-1030 covers specifications of encapsulated resistors.—Cinema Engineering Co., 1100 Chestnut St., Burbank, Calif.

Circle **598** on inquiry card.

Rheostats. New 2-page issue of "Ohmite News" (Aug.-Sept. '54) describes and illustrates rheostats used for lamp dimming and rheostat tandem coupling kits consisting of a steel "U" frame, mica washer, coupling, Allen wrench and assembly instructions.—Ohmite Mfg. Co., 3603 Howard St., Skokie, Ill.

Circle **599** on inquiry card.

Potentiometers. New 2-page issue "Centralab Engineering Preview" describes maker's "Snap-tite" pots designed to save assembly time and cost.—Centralab, Div. of Globe-Union, Inc., Milwaukee, Wisconsin.

Circle **600** on inquiry card.

Potentiometers. New 8-page Catalog 9 describes and illustrates precision helical-type potentiometer; standard series potentiometers; series "A" Multipot.—Ford Engineering Co., 129 East A St., Upland, Calif.

Circle **601** on inquiry card.

Trimming Potentiometer. Two new 2-page sheets describes "Model 100" linear trimming potentiometer for miniaturized equipment; and "Series H Multipot" hermetically-sealed potentiometers.—Ford Engineering Co., 129 East A St., Upland, Calif.

Circle **602** on inquiry card.

Potentiometers. New 2-page illustrated bulletin presents description and specification of maker's single-turn "Model 100 Series" potentiometers.—Spectrol Corp., 1704 S. Del Mar, San Gabriel, Calif.

Circle **603** on inquiry card.

Wire-wound Potentiometers. New 4-page leaflet describes maker's precision linear wire-wound potentiometers, including miniature and low-torque units.—Vectron, Inc. 400 Main St., Waltham 54, Mass.

Circle **604** on inquiry card.

Precision Potentiometers. New 2-page brochure describes and pictures maker's "#500 Acepot," a subminiature wire-wound precision potentiometer.—Ace Electronics Assoc., 125-129 Rogers Ave., Somerville 4, Mass.

Circle **605** on inquiry card.

Potentiometer. New 1-page Bulletin B53 describes maker's "Type 2094" high-resolution rotational potentiometer.—Markite Corp., 155 Waverly Place, N. Y. 14, N. Y.

Circle **606** on inquiry card.

Microfriction Potentiometer. New 4-page brochure describes maker's new "Telepot" microfriction potentiometer with low torque and high precision.—F. H. Paul & Stein Bros., Inc., 100 Gold St., N. Y. 38, N. Y.

Circle **607** on inquiry card.

SWITCHES, RELAYS

Precision Relays. New 44-page catalog describes and illustrates midget relays; circuit controls which give any possible contact system desired, up to maximum of 4PDT; radio and high-frequency relays; aircraft relays; aircraft contactors; and special-purpose relays.—Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle **608** on inquiry card.

Time-delay Relays. New 2-page Bulletin SR-6 describes maker's "Model NEH" time-delay relay with double-throw auxiliary switch for push-button operation, or instant or delayed contacts after deenergization.—AGA Div., Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J.

Circle **609** on inquiry card.

Industrial Relays. New 10-page Circulars 1801-1805 cover descriptions, drawings, wiring diagrams and specifications of maker's plug-mounted, industrial relays.—Automatic Electric Sales Corp., 1033 West Van Buren St., Chicago 7, Ill.

Circle **610** on inquiry card.

Relay Panel. New 2-page Bulletin 546 covers application description, operation, and dimensions of maker's "108S10C" relay panel for gas valve.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle **611** on inquiry card.

Solenoid Contactors. New 8-page Bulletin SC-9 describes a wide range of enclosed solenoid contactors with power ranges to 250 amperes. Includes complete technical data.—Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

Circle **612** on inquiry card.

Toggle Switches. New 2-page Data Sheet P93 describes and illustrates maker's 3-position toggle switches "Series 11AT" for aircraft, mobile, marine, electronic and appliance applications.—Micro Switch Div., Minneapolis-Honeywell Reg. Co., Freeport, Ill.

Circle **613** on inquiry card.

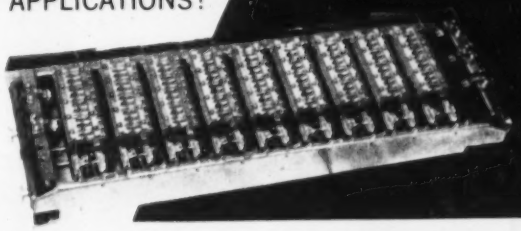
Push Buttons. New 6-page Bulletin GEA-6061 pictures and describes maker's motor starters and push buttons.—General Electric, Schenectady 5, N. Y.

Circle **614** on inquiry card.

FAST CIRCUIT SELECTION or INTERCONNECTION!

MANY DIFFERENT APPLICATIONS!

KELLOGG Crossbar Switch for Automatic Control Systems and Computers



Kellogg Crossbar Switch provides the fast, low-cost means of interconnecting or selecting many different circuits common to large-scale switching required by automatic control systems or computers. Its many applications include, for example, connecting any 3 of 60 circuits to any of 75—or choosing 1 circuit from as many as 936. It provides circuit connections in 50 milliseconds by energizing two specific coils. For optimum fidelity of signal and prevention of corrosion, palladium contact points are used. Mounted for drawerlike removal from its rack. Get the complete facts—Write Kellogg's Industrial Sales Dept. 61 today.

KELLOGG — Division of IT&T

KELLOGG SWITCHBOARD AND SUPPLY COMPANY

A Division of International Telephone and Telegraph Corporation

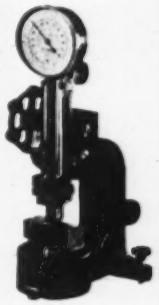
SALES OFFICES: 79 West Monroe Street, Chicago 3, Illinois

For more information circle **176** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 47 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.

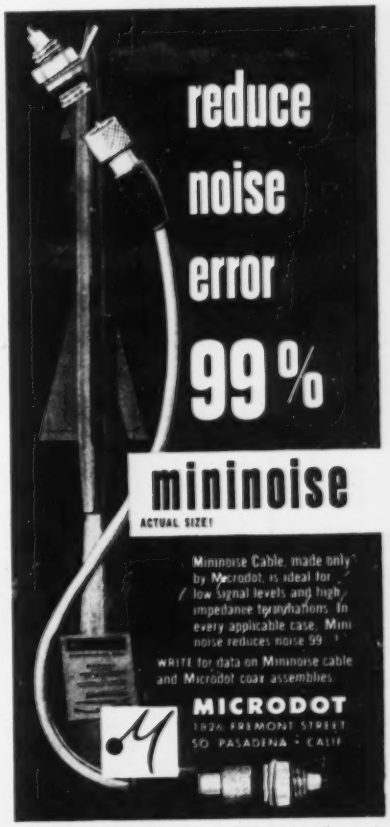


Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway Jamaica 35, N. Y.

For more information circle **177** on inquiry card.


reduce
noise
error
99%
mininoise
ACTUAL SIZE!
Mininoise Cable, made only by Microdot, is ideal for low signal levels and high impedance terminations. In every applicable case, Mininoise reduces noise 99%
WRITE for data on Mininoise cable and Microdot coax assemblies.
MICRODOT
1826 FREMONT STREET
SO. PASADENA • CALIF.

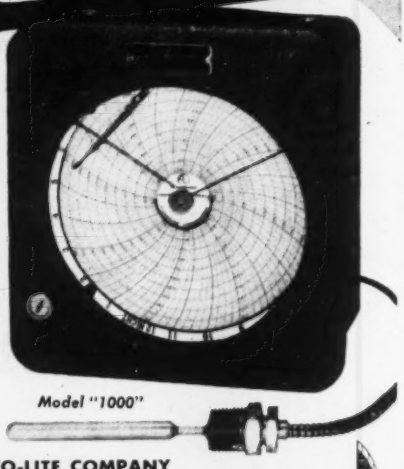
For more information circle **178** on inquiry card.

AUTO-LITE

TEMPERATURE RECORDING...

Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior. • 6" clear reading chart; various standard ranges from minus 40°F. to plus 550°F. • 3 standard types; choice of 24-hr. or 7-day cycle. • Electric or mechanical chart drive. • With capillary tubing for remote reading. Priced from $49.50.

Send for new catalog describing many styles of Auto-Lite temperature Recorders and Indicators.



Model "1000"

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO

TEMPERATURE RECORDERS

For more information circle **179** on inquiry card.

Fine
PRESSURE GAGES...

—are the result of good design, careful selection of materials and meticulous care in manufacturing.

In the Acragage you get these three vital factors plus the famous solid front with full area blow out disc.

Catalog M-50 tells much about these better Acragages.

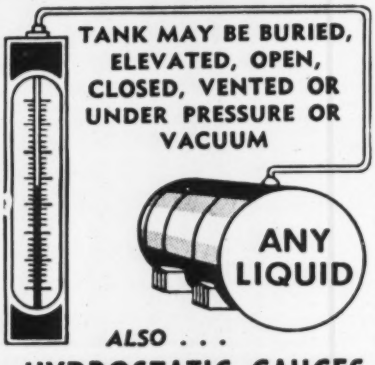
Send for your copy today.

The ACRAGAGE *Corporation*

WAMPUS LANE • MILFORD, CONN.

For more information circle **180** on inquiry card.

TANK-O-METER
FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



ALSO . . .

HYDROSTATIC GAUGES
FOR ALL PURPOSES
PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
DIFFERENTIAL PRESSURE
MERCURIAL BAROMETERS

SEND FOR BULLETINS

UEHLING INSTRUMENT CO.
470 GETTY AVE., PATERSON, N. J.

For more information circle **181** on inquiry card.

NEW LITERATURE

Toggle Switches. New 4-page issue (Vol. 9, No. 1) of "Uses Unlimited" presents high-temperature switches. New 4-page issue (Vol. 1 No. 14) of "Micro Tips" presents two snap-action switches adding safety to tumbling machines. Data sheet P93 describes 3-position toggle switches for use in aircraft, mobile, marine etc.—Micro Switch Div., Minneapolis-Honeywell, Freeport, Ill.

Circle **615** on inquiry card.

Electrical Switches. New 4-page illustrated brochure describes maker's flow-actuated electrical switches.—Power Engineering & Equipment Co., Inc., 2093 Torrance Blvd., Torrance, Calif.

Circle **616** on inquiry card.

ELECTRONIC COMPONENTS

Plug-in Circuits. New 32-page illustrated Bulletin 81554 presents circuits and specifications for 29 plug-in units, including amplifiers, multivibrators, etc.—EECO Production Co., 827 S. Vermont Ave., Los Angeles 5, Calif.

Circle **617** on inquiry card.

Graphic Circuit Kit. New 2-page bulletin describes maker's S31 basic laboratory kit for laboratory's engaged in electronic development or basic research. Includes electrically conductive coatings and accessories.—Micro-Circuits Co., New Buffalo, Mich.

Circle **618** on inquiry card.

Delay Lines. New 12-page Catalog 54 includes descriptions, technical data and illustrations of maker's lumped-constant, distributed-constant and ultrasonic delay lines.—Richard D. Brew & Co., Inc., Airport Rd., Concord, N. H.

Circle **619** on inquiry card.

Core Ballasts. New 4-page Bulletin GEA-6040 presents information and ratings for maker's clamped-core ballasts for fluorescent fixtures.—General Electric, Schenectady 5, N. Y.

Circle **620** on inquiry card.

Connectors. New 8-page issue of "Engineering News" (Vol. 7 No. 5) features articles on development of hermetically-sealed connectors.—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle **621** on inquiry card.

Miniature Connectors. New 4-page Brochure SR-KM1 describes maker's "K" miniature connectors, including hermetic seal for computer field.—Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.

Circle **622** on inquiry card.

Connectors. New 2-page illustrated bulletin includes electrical and mechanical specifications of maker's "Series 20T" rectangular miniature connector with turret terminals.—DeJur-Amsco Corp., 45-10 Northern Blvd., L. I. C. 1, N. Y.

Circle **623** on inquiry card.

Transformers. New 28-page Catalog TR-54 describes and illustrates high-fidelity output transformers, toroidal coils for wave filters, and "Geoform-

ers" for geophysical prospecting equipment.—Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Circle **624** on inquiry card.

Transformers. New postcard pictures maker's electrical test instruments and transformers. Gives models, capacities, features, and catalogs available.—Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn 27, N. Y.

Circle **625** on inquiry card.

Bobbin Cores. New 4-page Bulletin BC-102 explains how maker's ultra-thin tape cores with rectangular hysteresis loops under pulse conditions are used in industry.—Magnetics, Inc., Butler, Pa.

Circle **626** on inquiry card.

Motor Capacitors. New 2-page Bulletin 158 describes maker's general-purpose booted-terminal motor capacitors "Type MKV".—Cornell-Dubilier Electric Corp., South Plainfield, N. J.

Circle **627** on inquiry card.

Pilot Lights. New 8-page Brochure Form L-155 describes pilot light lamps with respect to various sizes, bulb shapes, bases and voltages.—Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle **628** on inquiry card.

Miniature Lamps. New 8-page catalog lists maker's globe, pear, and tubular-shape "Sol-Rex" miniature incandescent lamps.—Herzog Miniature Lamp Works, 12-23 Jackson Ave., Long Island City, N. Y.

Circle **629** on inquiry card.

Pilot-light Assemblies. New 18-page Catalog 9P CAT illustrates and describes maker's line of dial and jewel pilot-light assemblies.—Drake Mfg. Co., 1713 West Hubbard St., Chicago 22, Ill.

Circle **630** on inquiry card.

Control Knobs. New 10-page catalog describes and illustrates maker's line of plastic knobs and control handles.—Rogan Brothers, 8025-33 North Monticello Ave., Skokie, Ill.

Circle **631** on inquiry card.

MAGNETICS

Magnetic Materials. New 12-page issue of "Applied Magnetics" (Vol. 2, No. 5) features articles on maker's "Hyflux Alnico V" permanent magnets and on magnetic testing.—Indiana Steel Products Co., Valparaiso, Indiana.

Circle **632** on inquiry card.

Magnets. New 4-page illustrated brochure presents description of maker's plant facilities and permanent magnets.—General Magnetic Corp., 10003 Erwin Ave., Detroit 34, Mich.

Circle **633** on inquiry card.

TUBING

Tubing Support. New 12-page Bulletin 254 describes and illustrates maker's expanded-metal system for permanent and continuous support or instrument tubing. Includes installation details.—Instrof, Inc., 4923 Pentridge St., Phila., Pa.

Circle **634** on inquiry card.

Tube Cutter. New 1-page bulletin describes and illustrates "No. 216A"

FOR
FAST GAS ANALYSIS

RANAREX®

Indicates, Records, Controls

• Combustion Gases • Chemical Process Gases • Petroleum & Refining Gases • Inert Atmospheres • Gas & Gas/Air Mixtures • Heat-treating Atmospheres • Gas Specific Gravity

ADVANTAGES!
High Accuracy
Continuous Measurement
. . . Short Lag
Simple Principle
Rugged Construction

A PERMUTIT™ PRODUCT

Write today for **FREE** Technical Bulletin
The Permutit Company, Dept. I-11
330 West 42nd Street, New York 36, N. Y.

For more information circle **182** on inquiry card.

King
MANOMETERS
Every Size-for Every Service

U-Type Manometers
- Single Cleanout
- Single Gland-Packed
- Double Cleanout
- Double Gland-Packed
- High Pressure

Well-Type Manometers
- Low Well
- Raised Well
- Barometric Reading

Multi-Tube Manometers
- Multi-Well
- Common-Well
- Special-Purpose

FREE LITERATURE gives sizes, construction and prices. Write today! And ask for informative 12-page Manual on Manometers.

KING ENGINEERING PRODUCTS include King-Gages — Pressure Transmitters — Sight Feed Bubblers — Overflow Check Valves — Air Flow Snubbers — Moisture Indicators

KING ENGINEERING CORP.
Box 70 • Ann Arbor, Mich.
REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **183** on inquiry card.

FILL DESIGN & LETTERING WITH COLOR

This Bench unit applies ink, paint or enamel colors to depressed or sunken surfaces—Ask for the

ACROPRINTER (Reg. U.S. Pat. Off.)

STAMP NAME-PLATES of steel, other metals or plastic with this fast operating ACROMARKER NAME PLATE STAMPING MACHINE.

The ACROMARK Company
3-11 MORRELL ST.
ELIZABETH 4, NEW JERSEY
"The Original Marking Specialists"

For more information circle **184** on inquiry card.

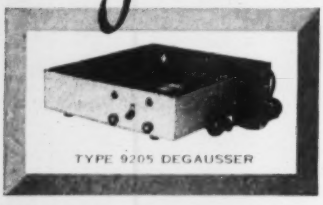
SEARCHLITE SECTION

CLASSIFIED ADVERTISING
EMPLOYMENT & BUSINESS OPPORTUNITIES

The advertising rate is $12.00 per inch for all advertising (An advertising inch is measured ⅞ inch vertically by 2¼ inches wide.)

Send advertisements to INSTRUMENTS & AUTOMATION, 845 Ridge Ave., Pittsburgh 12, Pa.

CINEMA'S
TAPE AND FILM
Degausser
CLEAN ERASURE OF MAGNETIC TAPE & FILM



Noise & program erasure. Use the best. Cinema's Bulk-Tank Type Degausser 9205. Economically priced. Buy yours today.

CINEMA ENGINEERING CO.
DIVISION AEROVOX CORPORATION
1100 CHESTNUT STREET • BURBANK CALIF

For more information circle **185** on inquiry card.

POCKET PYROMETER

- SHOCK RESISTANT
- VERSATILE
- ACCURATE
- SENSITIVE

CYBERTRONIC CORP. OF AMERICA
3rd & Morton Aves. • Chester, Pa.

For more information circle **186** on inquiry card.

FLOW INDICATORS
All sizes up to 6"
SEND FOR CATALOG
ERNST
Water Column & Gage Co.
LIVINGSTON, N. J.

CYLINDER — DOUBLE WINDOW

For more information circle **187** on inquiry card.

O-Z Hand TACHOGRAPH
Draws Graphic Speed Charts
RPM. FPM—FLUCTUATIONS
30-48000—Accuracy 0.5%
Write for Circulars
O. ZERNICKOW CO.
21 Park Row, New York 38, N. Y.

For more information circle **188** on inquiry card.

CYBER-TAC
TEMPERATURE CONTROLLER

VERSATILE
STABLE
SAFE!

- Indicates . . Limits . . Controls!
- Thermocouple break protection!
- Unique Electronic Circuit . . stable under all conditions, including wide voltage variations . . It's FAIL-SAFE!
- Price $105.00

Write for complete literature

CYBERTRONIC CORP. OF AMERICA
DEPARTMENT 11, INDUSTRIAL CENTER
3RD & MORTON AVES., CHESTER, PENNA.
A Few Territories Still Open For Mfg's Agents

For more information circle **189** on inquiry card.

VISCOMETERS

All A.S.T.M. sizes and many special sizes in stock.

I. Cannon-Fenske Type
II. Ubbelohde Type
III. Opaque Type
IV. Cannon-Ubbelohde Type
V. Semi-Micro Type

(1.0 ml charge required)
All calibrations double checked.
Our 17th year of service.
Write for bulletin 15

CANNON INSTRUMENT COMPANY
Box 812 STATE COLLEGE, PA.

For more information circle **190** on inquiry card.

TIME DELAY

Haydon relay 115v 60 cy adjustable in 5 sec. steps to 30 seconds max. 3½x3½x2½ $4.50

4PDT RELAY

Midget 12 vdc 70Ω $1.65	425Ω 24vdc	$2.75
3PDT Clare K 250Ω 24vdc		1.95
SPDT 6 vdc 35Ω cer. insul. Dunco 181		1.25
115 vac 60 cy SPDT P. & B. #MR5A		1.95
ERIE #557 silver trimmer 3-12 NPO		.16
Transistor or 5 pin submini socket		.13

All material is from excess inventories & is new and guaranteed. Write for Bulletin

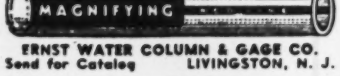
EMPIRE ELECTRONICS CO.
409d Ave. L. Brooklyn 30, N. Y. CL 2-4000

For more information circle **191** on inquiry card.

AURICON
Professional 16mm Motion Picture Cameras and Sound-On-Film Recording Equipment.
Write for Free illustrated Folder.
BERNDT-BACH, Inc.
6962 Romaine St., Hollywood 38, Calif.
SOUND-ON-FILM SINCE 1931

For more information circle **192** on inquiry card.

GAGE GLASSES AND
High Pressure Rubber Gaskets
ALL SIZES TO FIT YOUR GAGES & VALVES



ERNST WATER COLUMN & GAGE CO.
Send for Catalog LIVINGSTON, N. J.

For more information circle **193** on inquiry card.

---

tube cutter which produces clean, square ends on steel and stainless-steel, copper, brass, and aluminum tubing.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **635** on inquiry card.

Wire, Tubing. New 44-page Catalog 54 covers maker's wires, cables, plastic tubing, coated tubing, sleeving, and identification markers.—William Brand & Co., Inc., Willimantic, Conn.

Circle **636** on inquiry card.

MATERIALS

Phosphor-bronze Strip. New 4-page Bulletin 4 describes maker's "Pennrold" phosphor-bronze strip, close-tolerance strip in Grades A and C.—Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

Circle **637** on inquiry card.

Gravoflex Plastic. New 2-page bulletin describes maker's "Gravoflex", flexible, laminated, shatter-proof, stain-resistant plastic.—Hermes Plastics, Inc., 13-19 University Place, N. Y. 3, N. Y.

Circle **638** on inquiry card.

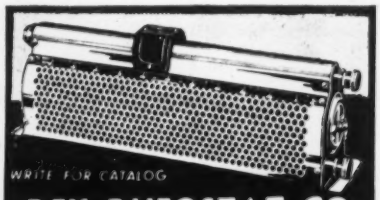
Titanium Foil. New technical data Bulletin 100 describes maker's commercially pure titanium foil. Includes tolerance chart, mechanical and electrical properties.—American Silver Co., Inc., 36-07 Prince St., Flushing, N. Y.

Circle **639** on inquiry card.

Tungsten. New 20-page illustrated Brochure NP-243 covers manufacture, properties, and uses of tungsten.—Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Circle **640** on inquiry card.

Synthetic Fibres. New 8-page bulletin describes maker's "Spinnerettes"



WRITE FOR CATALOG
REX RHEOSTAT CO.
BALDWIN, L. I., N. Y.

For more information circle **194** on inquiry card.

New 60-page 1954 catalog on
Paint Testing Instruments
is now available
A copy will be sent on request.
GARDNER LABORATORY, INC.
Bethesda 14, Md.

For more information circle **195** on inquiry card.

MANUFACTURER'S AGENT
Calling on Chicago Area, Northern Indiana, & Wisconsin Industrial Accounts seeks Instrumentation and Control Lines. Box 280, Instruments Publishing Company, 845 Ridge Avenue, Pittsburgh 12, Penna.

for synthetic fibers.—Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

Circle **641** on inquiry card.

Stainless Steel. New 4-page Brochure TDC-162 describes the welding of stainless tubular products; outlines the welding characteristics of stainless steels; describes various welding methods—metallic-arc, oxyacetylene, atomic-hydrogen, inert gas arc and flash-butt welding.—Babcock & Wilcox Co., Beaver Falls, Pa.

Circle **642** on inquiry card.

Laminated Plastics. New 1-page government specification chart for thermosetting laminated plastics describes composition of 24 grades of tubing, rods, and sheet stock covered. —Synthane Corp., Oaks, Pa.

Circle **643** on inquiry card.

Plexiglas Sheets. New 4-page Bulletin is price list for maker's plexiglas sheets including colored sheets.—Kaufman Glass Co., 1209-21 French St., Wilmington, Del.

Circle **644** on inquiry card.

Cast Stainless Alloys. New set of 13 data sheets cover properties of all popular grades of alloys for corrosion-resistant stainless-steel castings.—Alloy Casting Institute, 32 Third Ave., Mineola, N. Y.

Circle **645** on inquiry card.

Industrial Coated Fabrics. New 8-page catalog describes maker's line of coated fabrics for industrial applications. Haartz-Mason, Inc., Mechanical Products Div., Watertown 72, Mass.

Circle **646** on inquiry card.

Polyester Film. New 16-page Technical Report TR-1 covers physical, electrical, and chemical properties of "Mylar" polyester film. E. I. Du Pont de Nemours & Co., Inc., Film Dept., Wilmington, Del.

Circle **647** on inquiry card.

Tool Steel Chart. New 4-page comparison chart shows general classification, SAE No., AISI No., and JIC No., for 15 different types of tool and die steels. Also brand names used by 12 leading mills.—Uddeholm Co. of America, Inc., 155 East 44 St., New York 17, N. Y.

Circle **648** on inquiry card.

PRECISION PARTS

Gear Box. New 8-page illustrated Bulletin LP-3502 5M-4-54 presents applications, features, dimensions and specifications of maker's "Model 012" precision gear box.—Link Aviation Inc., Binghamton, N. Y.

Circle **649** on inquiry card.

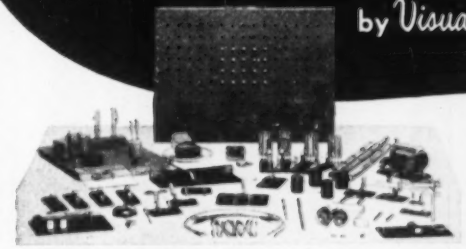
Nameplates. New 6-page data file covers description, available material, sizes, shapes and colors, and applications of "Metal-Cal" nameplates and labels. Includes samples.—C & H Supply Co., 415 E. Beach Ave., Inglewood 3, Calif.

Circle **650** on inquiry card.

Clamps. New 60-page Engineering Manual 201G presents design data on maker's wire harness clamps, bonding clamps, brackets, multiple support clamps, shims, tube clamps, etc.—Thomas Associates, 4607 Alger St., Los Angeles 39, Calif.

Circle **651** on inquiry card.

NOW . . . a Practical, Low-Cost Method for ELECTRICAL TRAINING by Visual Experiment



CROW ELECTRI-KIT model 41-B

● Everyone from management to production line can now receive a thorough grounding in the principles of electricity. With the Crow Electri-Kit you *learn by doing*. No mathematical background needed.

The Electri-Kit contains 115 parts for building a related series of operating assemblies. You can perform 230 experiments in all, each designed to illustrate a definite electrical principle. A work-manual explains every step in plain English.

FOR INDUSTRIAL TRAINING PROGRAMS or HOME STUDY

Taking their cue from its outstanding success in schools, many plants have found the Electri-Kit ideal for training their personnel in this important subject. Quantity discounts available. Write for new bulletin.

Experiments and Assemblies Cover

Permanent Magnetism • Electro-Magnetism
Circuitry, Switches and Fuses • Transformers
Bells, Buzzers, Relays, and Thermostats
DC and AC Electric Motors and Controls

PRICE—complete with manual, transformer and oak case—only **$47.50**

CROW ELECTRI-CRAFT CORPORATION

DIV. OF UNIVERSAL SCIENTIFIC CO., INC. • BOX 336W, VINCENNES, INDIANA

For more information circle **196** on inquiry card.

MECHANICAL INSTRUMENT DESIGNER

(Senior)

Well established instrument manufacturer located in Metropolitan New Jersey requires the services of a Senior Mechanical Instrument Designer to design new types of mechanical recorder and air operated recorder controller instruments for the Process Control field.

Applicants should have a degree in Engineering, a minimum design experience of five (5) years in a responsible capacity and a proven and demonstrable attainment in having successfully served the Batch Process Control market. Submit resume, list of accomplishments, availability and salary expected to: Box 279, Instruments Publishing Company, 845 Ridge Avenue, Pittsburgh 12, Penna.

PRECISION

POTENTIOMETERS

LINEAR – NON-LINEAR

Rattray precision potentiometers have a wide scope and cover many types and sizes, in the field of wire-wound units of high accuracy, long life and stability.

If you have a requirement involving procurement of precision potentiometers, in small or large quantities — see us first for the best in standard and special designs.

Model 162-C shown here is typical of our compact design, with mechanical and electrical capabilities of highest quality, as shown by comparative tests.

Technical Bulletin 5-54 Now Available

GEORGE RATTRAY & CO., Inc.
116-08 MYRTLE AVENUE
RICHMOND HILL 18, N. Y.

For more information circle **197** on inquiry card.

ADVERTISERS' INDEX

A

Abrams Instrument Corp. 1700
Acragage Corp. 1860
Acromark Company 1861
A'G'A Division of Elastic Stop Nut Corp. of America 1834
Airpax Products Company 1853
Allegany Instrument Company 1778
Allied Radio Corp. 1841
American Electric Motors, Inc. 1748
American Electronic Mfg., Inc. 1752
American Machine & Metals, Inc. 1697
American Meter Company 1773
American Phenolic Corporation 1776
American Time Products, Inc. 1710
Amperite Co., Inc. 1756
Amthor Testing Instrument Co. 1854
Annin Company 1703
Aros Electric, Inc. 1721
Atkomatic Valve Company 1782
Atlas Valve Company 1722
Audio Devices, Inc. 1839
Automatic Electric Mfg. Co. 1753
Automatic Electric Sales Corp. 1733
Automatic Temperature Control Co. 1841

B

Bailey Meter Co. 1743
Baldwin-Lima-Hamilton Corporation Inside Back Cover
Barber-Colman Company 1746
Barber-Colman Company, Wheelco Instruments Division 1737
Bendix Aviation Corporation 1717, 1755
Berndt-Bach, Inc. 1862
B-I-F Industries, Inc. 1840
Black, Sivalls & Bryson, Inc. Inside Front Cover
Blue M Electric Company 1825
Bourns Laboratories 1772
Bowser, Inc. 1856
Bristol Company 1694-1695, 1739
Brown Instruments Division of Minneapolis-Honeywell Regulator Co. 1768-1769
Brush Electronics Company 1711
Builders-Providence, Inc. 1840
Burgess Battery Company 1826

C

Cambridge Instrument Co., Inc. 1825
Cannon Electric Co. 1701
Cannon Instrument Company 1862
Chatillon & Sons, John 1729
Chesapeake Instrument Corporation 1831
Cinema Engineering Co. 1838, 1862
Clifton Precision Products Company, Inc. 1779
Commercial Research Laboratories, Inc. 1708
Conoflow Corporation 1833
Consolidated Engineering Corp. 1735, 1835
Control Engineering Corporation 1681
Control Products, Inc. 1777
CONVAIR 1851
Cramer Co., Inc., R. W. 1840
Crawford Fitting Co. 1730
Crescent Insulated Wire & Cable Co. 1698
Crow Electri-Craft Corporation 1863
Crucible Steel Company of America 1771
Cybertronic Corp. of America 1862

D

Dahl Company, George W. 1686
Davis Emergency Equipment Co., Inc. 1738
Detectron Corporation 1838
Diamond Power Specialty Corp. 1752
Diehl Manufacturing Company 1751
Doelcam Corporation 1731
Dwyer Mfg. Co., F. W. 1833

E

Eagle Signal Corporation 1736
Edmund Scientific Corp. 1829
Electric Auto-Lite Co. 1846, 1860
Electro Products Laboratories, Inc. 1834
Electronic Associates Inc. 1749
Empire Electronics Company 1862
Epic, Inc. 1835
Eppley Laboratory, Inc. 1831
Ernst Water Column & Gage Co. 1862
Esco Products Company 1853

F

Falstrom Company 1674
Federal Products Corporation 1709
Fielden Instrument Division 1728
Foster Engineering Company 1780
Foxboro Company 1716
Friez Instrument Div., Bendix 1755
Fulton Sylphon Division 1783

G

Gaertner Scientific Corp. 1760
Gardner Laboratory Inc. 1862
General Electric Company 1676-1677, 1678-1679
Genisco Incorporated 1757
Giannini & Co., Inc., G. M. 1750
Gilman, Inc., Russell T. 1833
G-M Laboratories, Inc. 1834
Goodyear Aircraft Corporation 1673
Gordon Co., Claud S. 1758
Green Instrument Co. 1850

H

Hagan Corporation 1715
Hammel-Dahl Company Back Cover
Hankison Corporation 1850
Hansen Manufacturing Co., Inc. 1707
Hartmann & Braun 1745
Haydon Company, A. W. 1855
Haydon Manufacturing Company, Inc. 1747
Hays Corporation 1713
Heiland, Div. of Minneapolis-Honeywell Regulator Co. 1845
Heise Bourdon Tube Co. 1858
Hewlett-Packard Company 1691
Hoke Incorporated 1781

I

Ideal Laboratory Tool & Supply Co. 1745
Illinois Testing Laboratories, Inc. 1835
Impact Register Company 1843
Imperial Brass Mfg. Co. 1836
Industrol Corp. 1782
Instrument & Control Consultants 1844
Instrument Laboratory Service 1760
International Development Company 1838

J

Jerguson Gage & Valve Co. 1744
Johnson Engineering Company Inc., Walton V. 1837
Jordan Electronic Mfg. Co., Inc. 1854

K

Karn Chemical Equipment Company 1780
Kellogg Switchboard & Supply Co. 1859
King Engineering Corporation 1861
Kirk & Blum Mfg. Co. 1688
Klipfel Valves, Inc. 1690
Kybernetes Corporation 1689

L

Lapp Insulator Co., Inc. 1692
Leeds & Northrup Co. 1718
Levin & Son, Inc., Louis 1836
Lewis Engineering Co. 1682
Librascope, Inc. 1857
Liquidometer Corp. 1839
Logan Engineering Co. 1836

M

Mallory & Co., Inc., P. R. 1702
Mantec Inc. 1778
Marsh Instrument Co. 1843
Marshalltown Mfg. Co. 1837
Martindale Electric Co. 1858
Measurements Corp. 1857
Mercoid Corporation 1848
Meriam Instrument Co. 1759
Mesure et Controle 1712
Meyer-Opticraft, Inc. 1785
Microdot Division, Felts Corp. 1859
Minneapolis-Honeywell Regulator Co., Industrial Division 1768-1769
Moeller Instrument Co. 1693
Monsell Co., John R. 1854
Morehouse Machine Company 1825

N

Nash Engineering Company 1714
New Hermes Engraving Machine Corp. 1782
Niagara Blower Company 1761

O

Offner Electronics Inc. 1742
Ohmite Mfg. Co. 1685

P

Pacific Div., Bendix 1717
Pacific Scientific Co. 1770
Palmer Thermometers, Inc. 1784
Panalarm Products, Inc. 1763
Parker Appliance Co. 1741
Permutit Company 1861
Philadelphia Thermometer Co. 1833
Photron Instrument Company 1837
Preis Engraving Machine Co., H. P. 1856
Pritchard Company of California, J. F. 1734
Production Instrument Company 1829
Progressive Service Company 1843
Pyrometer Instrument Company 1852

R

Rattray & Co., Inc., George 1863
Rex Rheostat Co. 1862
Rockwell Co., W. S. 1762
Rockwell Manufacturing Company 1705
Rubicon Co. 1674

S

SCAM Corporation 1774
Schaevitz Engineering 1841
Scherr Co., Inc., George 1839, 1848
Servo Corporation of America 1855
Shore Instrument & Mfg. Co. 1859
Skinner Electric Valve Div. 1775
Smith Co., S. Morgan 1764
Sorensen & Co., Inc. 1766
Sprague Engineering and Sales Corp. 1826
Standard Electric Time Company 1687
Statham Laboratories 1740
Stevens-Arnold Inc. 1840
Struthers-Dunn, Inc. 1765
Swartwout Company 1696

T

Taylor & Co., W. A. 1732
Technical Charts Incorporated 1852
Tensitron, Inc. 1856
Texas Instruments, Incorporated 1706, 1754
Thermo Electric Co., Inc. 1767
Trinity Equipment Corp. 1852

U

Uehling Instrument Co. 1860
Unertl Optical Co., John 1858
United States Gauge, Div. of American Machine & Metals, Inc. 1697
United States Radium Corp. 1849

V

Vapor Recovery System Company 1847
Veeder-Root Inc. 1704
Viking Electric 1754

W

Wallace & Tiernan Incorporated 1699
Welch Scientific Co., W. M. 1727
Weston Electrical Instrument Corp. 1680
Wheelco Instruments Division, Barber-Colman Company 1737

Z

Zenith Electric Company 1827
Zernickow Company, O. 1862

Keep up-to-date on

- ✓ **INSTRUMENTATION**
- ✓ **AUTOMATIC CONTROL**
- ✓ **AUTOMATION**

a 1-year subscription to

INSTRUMENTS and AUTOMATION

— for 28 years the world's leading magazine of measurement and control —

brings you more than 2000 pages of instrumentation data for as little as $2.00 per year

Details on next page

Use This Subscription Card ➧

Inquiry Card ➧

For further details concerning developments reported in advertisements, New Product or New Literature reviews, CIRCLE THE NUMBER corresponding to that which appears with the ad or write-up.

When indicating change of address, kindly note old address.

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue, Pittsburgh 12, Pa.

I am sending $_____herewith, being payment in full for the subscriptions for INSTRUMENTS AND AUTOMATION listed below.

Signed .....

Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

For additional names use another sheet

please fill in COMPLETELY:

Name ..... **Title** .....

Company .....

Products Manufactured .....

Company Address ..... **City** ..... **Zone**..... **State**.....

☐ **Check for address change. Show OLD address here:** .....

Instruments and Automation Nov. '54
Good until 2-1-55

Advertised Products

1	23	45	67	89	111	133	155	177	199
2	24	46	68	90	112	134	156	178	
3	25	47	69	91	113	135	157	179	
4	26	48	70	92	114	136	158	180	
5	27	49	71	93	115	137	159	181	
6	28	50	72	94	116	138	160	182	
7	29	51	73	95	117	139	161	183	
8	30	52	74	96	118	140	162	184	
9	31	53	75	97	119	141	163	185	
10	32	54	76	98	120	142	164	186	
11	33	55	77	99	121	143	165	187	
12	34	56	78	100	122	144	166	188	
13	35	57	79	101	123	145	167	189	
14	36	58	80	102	124	146	168	190	
15	37	59	81	103	125	147	169	191	
16	38	60	82	104	126	148	170	192	
17	39	61	83	105	127	149	171	193	
18	40	62	84	106	128	150	172	194	
19	41	63	85	107	129	151	173	195	
20	42	64	86	108	130	152	174	196	
21	43	65	87	109	131	153	175	197	
22	44	66	88	110	132	154	176	198	

New Instruments

201	223	245	267	289	311	333	355	377	
202	224	246	268	290	312	334	356	378	
203	225	247	269	291	313	335	357	379	
204	226	248	270	292	314	336	358	380	
205	227	249	271	293	315	337	359	381	
206	228	250	272	294	316	338	360	382	
207	229	251	273	295	317	339	361	383	
208	230	252	274	296	318	340	362	384	
209	231	253	275	297	319	341	363	385	
210	232	254	276	298	320	342	364	386	
211	233	255	277	299	321	343	365	387	
212	234	256	278	300	322	344	366	388	
213	235	257	279	301	323	345	367	389	
214	236	258	280	302	324	346	368	390	
215	237	259	281	303	325	347	369	391	
216	238	260	282	304	326	348	370	392	
217	239	261	283	305	327	349	371		
218	240	262	284	306	328	350	372		
219	241	263	285	307	329	351	373		
220	242	264	286	308	330	352	374		
221	243	265	287	309	331	353	375		
222	244	266	288	310	332	354	376		

New Literature

401	423	445	467	489	511	533	555	577	599	621	643
402	424	446	468	490	512	534	556	578	600	622	644
403	425	447	469	491	513	535	557	579	601	623	645
404	426	448	470	492	514	536	558	580	602	624	646
405	427	449	471	493	515	537	559	581	603	625	647
406	428	450	472	494	516	538	560	582	604	626	648
407	429	451	473	495	517	539	561	583	605	627	649
408	430	452	474	496	518	540	562	584	606	628	650
409	431	453	475	497	519	541	563	585	607	629	651
410	432	454	476	498	520	542	564	586	608	630	
411	433	455	477	499	521	543	565	587	609	631	
412	434	456	478	500	522	544	566	588	610	632	
413	435	457	479	501	523	545	567	589	611	633	
414	436	458	480	502	524	546	568	590	612	634	
415	437	459	481	503	525	547	569	591	613	635	
416	438	460	482	504	526	548	570	592	614	636	
417	439	461	483	505	527	549	571	593	615	637	
418	440	462	484	506	528	550	572	594	616	638	
419	441	463	485	507	529	551	573	595	617	639	
420	442	464	486	508	530	552	574	596	618	640	
421	443	465	487	509	531	553	575	597	619	641	
422	444	466	488	510	532	554	576	598	620	642	

Desire product information from Exhibitor in booth no. .....

Read
INSTRUMENTS and AUTOMATION

for the latest developments in

AUTOMATION • AUTOMATIC CONTROL • INSTRUMENTATION

Regular one-year subscription price is $4.00,

BUT . . .

on two or more new subscriptions

or renewals sent together *on one order,*

the rates are reduced as follows:

2 separate one-year subscriptions **$6.00**

3 separate one-year subscriptions **$7.50**

4 separate one-year subscriptions **$9.00**

5 separate one-year subscriptions **$10.00**

Offer good only in U.S. and Canada

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

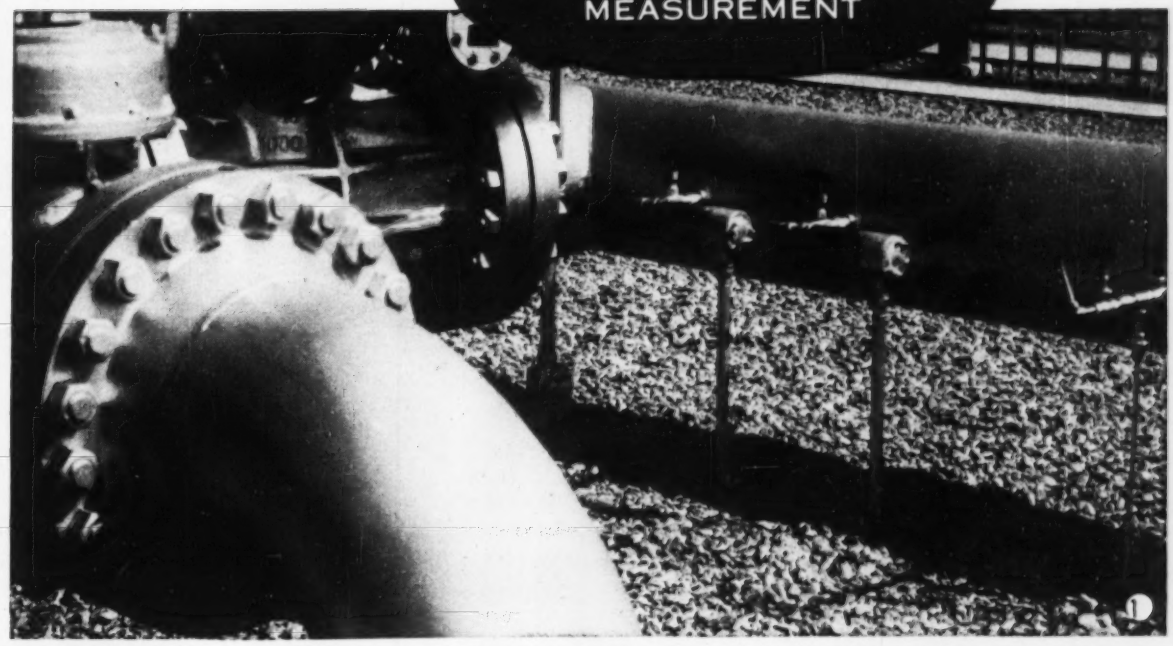
3c POSTAGE WILL BE PAID BY—

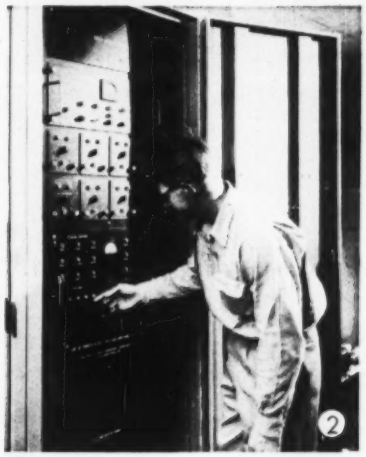
INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

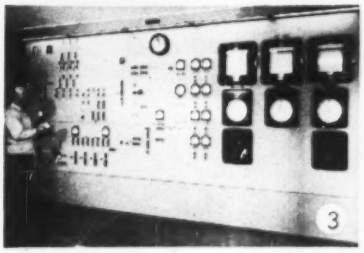
In one year I & A brings You more than

- 2000 pages of instrumentation data.
- 2000 reviews of new instruments.
- 2000 indexed literature items.
- 2000 indexed listings of instrument manufacturers and their products.

PACKAGED PRECISION MEASUREMENT







Pressures from SR-4 cells installed on suction and discharge lines at all ten stations (Photo 1) are channeled through the Baldwin console which is the brains of the remote pressure indicating system (Photo 2) to a master control panel (Photo 3) which shows at a glance pressure readings at all points.

A leading pipe line company reports:

"Corrosion-proof Baldwin SR-4® Pressure Cells let us measure remotely all pumping along 670-mile 'Big Inch'"

Reports a leading pipe line company: "We're using safe, accurate, corrosion-proof SR-4 Pressure Cells to control remotely all pumping along a new 22 inch crude oil pipeline. This 670-mile pipeline uses ten pumping stations, all controlled remotely through a telemetering system out of one control station hooked up to SR-4 Pressure Cells at each of the other stations. The SR-4 System gives us these important benefits:

"High Accuracy—Their dependable accuracy makes frequent calibration of the SR-4 Pressure Cells unnecessary. They are not affected by pressure pulsations of the pumps.

"Remote Indicating—Remote indicating SR-4 cells make it possible to control all ten stations through one.

"Corrosion Protection—The SR-4 cells are corrosion-proof preventing costly replacement and maintenance shut-downs of the lines.

"Explosion-Proof—The SR-4 cells have no moving parts to create a friction-spark fire hazard."

You, too, will profit many ways when you use accurate, dependable *Baldwin Packaged Precision Measurement* . . . for any pressure, load or torque measuring application. Send today for our illustrated bulletins that tell you how. Write to Department 3215, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

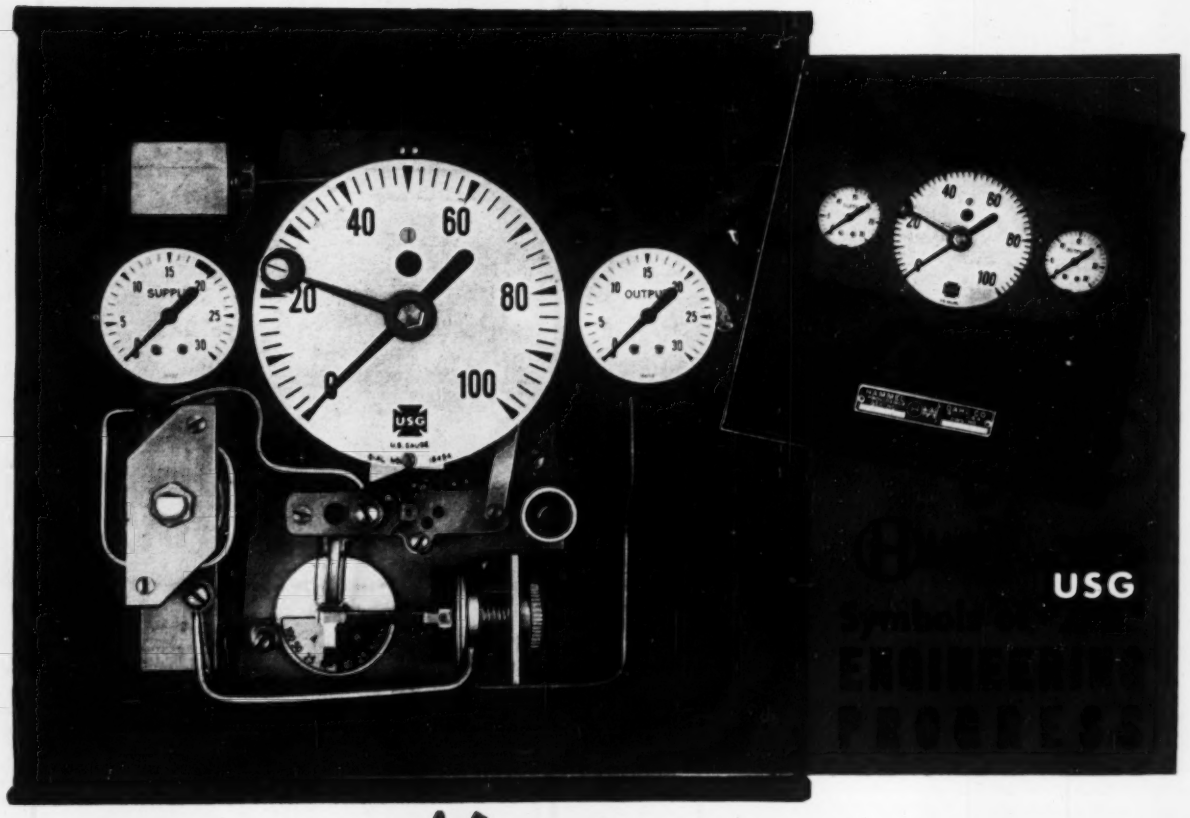
BALDWIN BLH LIMA-HAMILTON

BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

In Canada: Peacock Bros., Ltd., Montreal, Quebec

For more information circle **198** on inquiry card.



announcing the *NEW* HAMMEL-DAHL PRESSURE PILOT

DESIGNED and MANUFACTURED By **U. S. GAUGE**—With all the skill gained through years of instrument manufacture. For **HAMMEL-DAHL**—To specifications that only years of experience in control valve applications could formulate.

COMPLETE Information in Bulletin **110**

Compare These Features

- Integral gauge for controlled pressure indication.
- Direct setting of control point on calibrated dial.
- Screwdriver adjustment for:
  - (1) PROPORTIONAL CONTROL
  - (2) DIFFERENTIAL GAP
  - (3) EASY REVERSAL OF ACTION

  } 1-100%
- Sapphire nozzle feed orifice with push button cleaner.
- All metal power relay and modern feedback action.

HAMMEL-DAHL COMPANY

175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.

SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

For more information circle **199** on inquiry card.